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Metro Denver Sludge Management Plan
Volume II

Engineering-Science, Inc, Berkeley, Calif

Prepared for

Environmental Protection Agency, Denver, Colo Region VIII

Feb 78

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16. ABSTRACT

This volume concerning the Metro Denver Sludge Management Plan presents written responses to the draft EIS, a discussion of the principal issues and problems with the project, and their resolution.

Written responses received on the draft EIS and at the public hearings held in conjunction with the review of the draft EIS are presented. Specific EPA responses are provided alongside the comments.

Thirty-one principal issues are identified and discussed. These issues are broken down into five areas: pipeline and central plant issues, drying site issues, present operations, alternatives and sludge use issues. Each of these are discussed in turn, with detailed information provided where needed. Issues are presented in a conslusive manner; i.e., they are either judged important, unimportant, or in need of further study. Appendix A contains a proposed list of grant conditions for successive phases of work on the Metro Denver sludge plan, based on the issues discussions. Appendix B contains the proposed State of Colorado guidelines for agricultural applications of sludge.

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FINAL

E.I.S.

VOLUME II

on

METRO DENVER SLUDGE MANAGEMENT PLAN

EPA Project Number: C0080341

by

U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION VIII, DENVER

February 1978

Approved By: Alan Merson
Regional Administrator

Prepared under Contract Number 68-01-3407 between

EPA and Engineering-Science, Inc.
600 Bancroft Way
Berkeley, California 94710

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1.b

ATTENTION

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This section provides a brief introduction to Volume II of the EIS. It explains the organization of Volume II and the reasons that EPA felt that this volume was necessary to clarify and discuss the important issues surrounding the proposed project.

SECTION A

INTRODUCTION

This EIS has been organized in the following manner: Volume I is an updated corrected version of the draft EIS. It contains the discussion of the required five points under NEPA. This volume (II) builds on the first volume by expanding discussion on critical issues involved with this project.

Readers who are familiar with the draft EIS, and are aware of the project and its impacts, can confine their reading to Volume II. Essentially Volume II represents work done by EPA on the EIS, after the release of the draft.

Volume II is organized as follows: The first section contains a copy of all of the written correspondence received on the draft EIS. Copies of written testimony given at the public hearing are also included. We have reviewed the oral comments given at the public hearing; we think that the written comments provided here adequately reflect all of the issues raised at the public hearing. Side-by-side with the written comments are EPA responses. Some of the questions and comments were of a specific or one-of-a-kind comment as to be answered directly. This is done on most of the letters.

Where a comment raises a general issue, one of interest to many persons or agencies, the reader is referred to the issues section of Volume II. Here the issues are discussed in more detail.

Thirty general issues were identified. Some were included because of the recurring interest of many citizens. Others were included because EPA itself felt more information or issue resolution was needed.

The issues are broken down into five areas: I, plant and pipeline issues; II, site issues; III, present operation issues; IV, alternatives issues; and V, sludge use issues. Every attempt was made to provide the latest information and to secure the positions of persons or agencies involved in the issue. The issues are framed as questions in order to better focus on the specific problem at hand.

Although a few new issues were raised in the draft review, we think the real value of the comments was to direct EPA as to where it should focus its attention on issues already raised in the draft EIS. We have developed the issues discussions to a point of resolution. Either the issue involved is important and needs some project modification or it is not. We have tried to present these discussions in a conclusive manner.

Finally, the Appendices in Volume II contain two important qualifications to the presently proposed Metro offsite solids project. Appendix A is a list of proposed grant requirements, most of which stem from the issues discussions. Appendix B is a copy of the Colorado Health Department's proposed sludge application guidelines. These requirements will be an essential part of the agricultural distribution operation of Metro Denver and other communities. As of this writing, they are still in proposed form and may be changed.

This section presents copies of the letters received during the course of the review of the draft EIS. Specific EPA responses are presented next to each letter. These letters are presented to give an idea of the way the public and other agencies viewed the project issues.

SECTION B

COMMENTS ON THE DRAFT EIS AND EPA RESPONSES

INTRODUCTION

This section contains the written comments received by EPA subsequent to the release of the draft EIS. Next to each of the comments is the specific EPA response or the location where the particular issue is addressed further in the final EIS. Preceding the written comments is a matrix showing each commenter, the pages on which a copy of the comments is found, and the particular issues addressed by each letter. This matrix thus provides a cross-reference for indication which commenter addressed which issue, as well as showing which page each letter is on.

In general, the letters are found on the left side of the page, with the EPA response on the right side. Where a letter addresses several issues, the sections of the letter specifically addressed and the response are both numbered for easy identification.

DRAFT EIS WRITTEN COMMENT AND ISSUES MATRIX

			ISSUES																					
Letter No.	Author	Page No.	I-1 Source Control of Heavy Metals	I-2, I-4 and I-5 Pipeline: Impacts, Archaeology and Contingency Plans	I-3 Water Rights Conflicts	I-6 IV-4 Denver Northside Sludge Management	II-1 II-2 Site Conditions and Groundwater Deterioration	II-3 Odor Problems	II-4 II-8 Site Conflicts - Land Values and Productivity Loss	II-5 Windblowing of Sludge	II-6 Surface Runoff, Site Flooding	II-7 II-9 Site Conflicts - Site Designation and Land Use Compatibility	II-10 Insect and Bird Problems	II-11 Research Needs and Public Education	II-12 II-13 Present and Future Drying Capacity	II-14 II-15 Marketing Problems and Emergency Disposal	III-1 Continuation of Present Operation	IV-1 Site Alternatives	IV-2 Groundwater Quality Control Alternatives	IV-3 Process Alternatives	V-1 Public Health Constraints: Pathogens, Salts, and Metals	V-2 Constraints - Alternative Applications	V-3 V-4 Marketing Problems and Constraints	V-5 Long-term Implications
1	Larry Brown, Climax Molybdenum Co.	9																				X	X	
2	U.S. Dept. of Air Force	10																X						
3	U.S. Energy Research & Development Admin.	11	X																					
4	Wm F. Sharp, Jr.	12						X														X	X	
5	Colo. Div. of Planning Dept. of Local Affairs	13																						
6	Colo. Div. of Wildlife Dept. of Natural Res.	14																						
7	Board of Water Commissioners	15	X																					
8	Metropolitan Denver Sewage Disposal Dist. No. 1	16																X						
9	City & Co. of Denver, D.P.W.	17																X						
10	Adams Co. Board of Commissioners	18										X	X											
11	U.S. Dept. of Agri., SCS	19		X			X		X			X												

Letter No.	12	13	14	15	16	17	18	19	20	21	22
Author	Federal Energy Administration	U.S. Dept. of Interior USGS	U.S. Dept. of HEW, Region VIII	Lillian M. Werner	Dept. of Army, Corps of Engineers	Catherine M. Mundell	Donald A. Walles	John Mundell	Lawrence E. Walles	State Historical Society of Colorado	Colo. Div. of Planning Dept. of Local Affairs
Page No.	21	23	24	25	27	28	30	31	33	35	36
ISSUES											
I-1 Source Control of Heavy Metals	X							X			
I-2, I-4 and I-5 Pipeline: Impacts, Archaeology and Contingency Plans	X									X	
I-3 Water Rights Conflicts											X
I-6 IV-4 Denver Northside Sludge Management											
II-1 II-2 Site Conditions and Groundwater Deterioration		X				X		X	X		X
II-3 Odor Problems	X					X		X			
II-4 II-8 Site Conflicts - Land Values and Productivity Loss						X					X
II-5 Windblowing of Sludge						X	X	X	X		
II-6 Surface Runoff, Site Flooding				X		X					
II-7 II-9 Site Conflicts - Site Designation and Land Use Compatibility											
II-10 Insect and Bird Problems											
II-11 Research Needs and Public Education				X		X		X			
II-12 II-13 Present and Future Drying Capacity	X						X		X		
II-14 II-15 Marketing Problems and Emergency Disposal						X		X	X		
III-1 Continuation of Present Operation						X					
IV-1 Site Alternatives	X			X		X		X	X		
IV-2 Groundwater Quality Control Alternatives											
IV-3 Process Alternatives	X			X							
V-1 Public Health Constraints: Pathogens, Salts, and Metals	X							X			
V-2 Constraints - Alternative Applications											
V-3 V-4 Marketing Problems and Constraints						X					
V-5 Long-term Implications											

DRAFT EIS WRITTEN COMMENT AND ISSUES MATRIX (Continued)

Letter No.	Author	Page No.	ISSUES																					
			I-1 Source Control of Heavy Metals	I-2, I-4 and I-5 Pipeline: Impacts, Archaeology and Contingency Plans	I-3 Water Rights Conflicts	I-6 IV-4 Denver Northside Sludge Management	II-1 II-2 Site Conditions and Groundwater Deterioration	II-3 Odor Problems	II-4 II-8 Site Conflicts - Land Values and Productivity Loss	II-5 Windblowing of Sludge	II-6 Surface Runoff, Site Flooding	II-7 II-9 Site Conflicts - Site Designation and Land Use Compatibility	II-10 Insect and Bird Problems	II-11 Research Needs and Public Education	II-12 II-13 Present and Future Drying Capacity	II-14 II-15 Marketing Problems and Emergency Disposal	III-1 Continuation of Present Operation	IV-1 Site Alternatives	IV-2 Groundwater Quality Control Alternatives	IV-3 Process Alternatives	V-1 Public Health Constraints: Pathogens, Salts, and Metals	V-2 Constraints - Alternative Applications	V-3 V-4 Marketing Problems and Constraints	V-5 Long-term Implications
23	Colo. Dept. of Health	9					X	X		X			X						X		X			
24	Colo. Dept. of Agri.	10		X			X	X	X	X		X						X			X	X	X	
25	Colo. Dept. of Natural Res., Geological Survey	11		X			X																	
26	Colo. Dept. of Natural Res., Div. of Water Res.	12			X		X																	
27	Colo. State Historical Society	13		X																				
28	U.S. Dept. of HUD	14																						
29	U.S. Dept. of Agri., Forest Service	15																						
30	Dasel E. Hallmark	16	X																					
31	U.S. Dept. of Interior	17		X	X		X				X					X	X			X		X	X	
32	Dr. F. Robt. McGregor	18												X									X	
33	City & Co. of Denver, D.P.W.	19			X	X																		

ISSUES	34	35	36	37	38	39	40	41	42	43	44
Author	Betty Mundell Bennett	Council on Environmental Quality	Tri-County District Health Department	U.S. Dept. of HEW, FDA	U.S. Dept. of Transportation, FAA	Benedetti, Opperman and Martinez	Adams Co. Board of Commissioners	Kalcevic Farms Inc.	John J. Sauter	Vincent Sauter	Lost Creek Groundwater Mgt. District
Page No.	59	60	63	67	69	71	75	83	97	99	103
I-1 Source Control of Heavy Metals				X			X				
I-2, I-4 and I-5 Pipeline: Impacts, Archaeology and Contingency Plans					X						
I-3 Water Rights Conflicts											
I-6 IV-4 Denver Northside Sludge Management											
II-1 II-2 Site Conditions and Groundwater Deterioration	X		X			X	X			X	X
II-3 Odor Problems					X		X		X	X	
II-4 II-8 Site Conflicts - Land Values and Productivity Loss	X	X			X					X	
II-5 Windblowing of Sludge							X	X		X	
II-6 Surface Runoff, Site Flooding										X	
II-7 II-9 Site Conflicts - Site Designation and Land Use Compatibility					X	X	X				
II-10 Insect and Bird Problems					X		X				
II-11 Research Needs and Public Education			X	X		X					
II-12 II-13 Present and Future Drying Capacity			X				X				
II-14 II-15 Marketing Problems and Emergency Disposal							X				
III-1 Continuation of Present Operation								X			
IV-1 Site Alternatives	X					X	X				
IV-2 Groundwater Quality Control Alternatives							X				
IV-3 Process Alternatives			X			X	X	X			
V-1 Public Health Constraints: Pathogens, Salts, and Metals				X			X	X	X		X
V-2 Constraints - Alternative Applications											
V-3 V-4 Marketing Problems and Constraints				X			X				
V-5 Long-term Implications							X				

DRAFT EIS WRITTEN COMMENT AND ISSUES MATRIX (Continued)

Letter No.	Author	Page No.	ISSUES																					
			I-1 Source Control of Heavy Metals	I-2, I-4 and I-5 Pipeline: Impacts, Archaeology and Contingency Plans	I-3 Water Rights Conflicts	I-6 IV-4 Denver Northside Sludge Management	II-1 II-2 Site Conditions and Groundwater Deterioration	II-3 Odor Problems	II-4 II-8 Site Conflicts - Land Values and Productivity Loss	II-5 Windblowing of Sludge	II-6 Surface Runoff, Site Flooding	II-7 II-9 Site Conflicts - Site Designation and Land Use Compatibility	II-10 Insect and Bird Problems	II-11 Research Needs and Public Education	II-12 II-13 Present and Future Drying Capacity	II-14 II-15 Marketing Problems and Emergency Disposal	III-1 Continuation of Present Operation	IV-1 Site Alternatives	IV-2 Groundwater Quality Control Alternatives	IV-3 Process Alternatives	V-1 Public Health Constraints: Pathogens, Salts, and Metals	V-2 Constraints - Alternative Applications	V-3 V-4 Marketing Problems and Constraints	V-5 Long-term Implications
45	John E. Mayer	109							X							X						X	X	
46	Weld County	110	X		X		X	X	X	X											X	X	X	X
47	Protest Petition	112																						
48	City of Brighton City Council	124																						
49	Brighton Chamber of Commerce	125																						
50	City and County of Denver, DPW	126																						
51	Alan L. Canter	127	X	X			X	X		X				X	X	X	X	X			X	X	X	

Letter #1

CLIMAX MOLYBDENUM COMPANY
A DIVISION OF **AMAX** INC.
HENDERSON MINE
Box 68
Empire, Colorado 80438
(303) 569-3221

November 30, 1976

Mr. Mike Gunsecki
U. S. Environmental Protection Agency
Rocky Mountain Prairie Region
Suite 900
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Gunsecki:

A previous letter from me pertaining to the use of sewage sludge for the reclamation of mined lands was included as part of Appendix F in the draft EIS on the Metro Denver Sludge Management Plan. I was unable to present testimony at the public hearings and, by way of this letter, would like to further substantiate my previous feelings.

The use of sewage sludge for reclamation of sterile mine waste covering the tailing ponds at AMAX Inc.'s Urad Mine is no longer experimental. Sludge is the single most important ingredient in the revegetation portion of the reclamation of the mine. Approximately 40 acres have been successfully revegetated with air-dried, anaerobically digested sludge from the Metropolitan Denver Sewage Disposal District's No. 1 plant. The reclamation plan timetable is on schedule, and approximately 4,000 dry-weight tons of sewage will be used by 1980. We are also using all available excess sludge from the Idaho Springs plant. The quantities from Idaho Springs are small and are not included in the above figure.

Overall, the use of sludge is proving more satisfactory in every respect than initially expected. Not only is it instrumental as a nutrient source and soil builder, it is also easy and unoffensive to work with. Equally as important, it is economical. Haulage costs 87 miles one way from the Lowry Bombing Range are considerable but are actually cheaper (all things considered) than using the required quantities of inorganics to accomplish the same end.

In short, I strongly endorse the proposal to recycle municipal wastes.

Sincerely,

Larry F. Brown

Larry F. Brown, Ph.D.,
Environmental Control Engineer

LFB:mb

EPA Response

We thank Mr. Brown for his letter of support for the project. The use of Sludge on reclamation of mine tailings has been shown to be of considerable benefit. We are particularly impressed that the economics for hauling sludge 87 miles one way continues to still be favorable. Such uses, however preferable, will still only constitute a small portion of the eventual sludge use.

Letter #2

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS LOWRY TECHNICAL TRAINING CENTER (ATC)
LOWRY AIR FORCE BASE, COLORADO 80230

REPLY TO ATTN OF: DEEV

8 OCT 1976

SUBJECT: Draft Environmental Impact Statement for Metro Denver Sludge Management Plan

TO: Regional Administrator
U. S. Environmental Protection Agency
Rocky Mountain - Prairie Region VIII
Suite 900
1860 Lincoln Street
Denver, CO 80203

Attn: Mr Mike Gansecki

After careful study of the Draft Environmental Impact Statement For the Metro Denver Sludge Management Plan of May 1976, we determined that the implementation of the proposed action or alternatives will not impact upon the mission of Lowry Air Force Base.

Walt H Fears
WALTER H FEARS, Col, USAF
Base Civil Engineer

EPA Response

Although we agree that neither the proposed actions nor any of its alternatives will affect the Lowry Air Force Base operations, the question of the availability and use of portions of the Lowry Bombing Range is critical to this EIS. By separate communication, EPA has received a map showing the current ownership of the Bombing Range. It is presented and discussed under the Issue IV-1, dealing with alternative sites for the proposed operation.

Letter #3

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

NOV 1 5 1976

Mr. John A. Green
Regional Administrator
U.S. Environmental Protection
Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Green:

This is in response to your transmittal dated July 28, 1976, requesting review and comment on the draft environmental impact statement and separate summary document for the Denver Metropolitan Sewage Disposal District's Sludge Management Plan.

We have reviewed the statement and summary document and have determined that the proposed action will not conflict with current or known future Energy Research and Development Administration programs. However, some discussion in the final statement should be given to the presence of organic pollutants in the sludge, which in industrial organic effluents has caused severe problems during land appliations in the past.

Thank you for the opportunity to review and comment on this draft statement.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

cc: CEQ (5)

EPA Response

Organic pollutants in sludge, particularly PCB's, have been recognized by EPA as a potential problem. Data has been presented by Metro showing organic and pesticide concentrations in their sludge. A more complete discussion on heavy metals and organic source control is found under Issue I-1.

Letter #4

DATE: November 12, 1976

TO: Mr. Mike Gansecki
U. S. Environmental Protection Agency
Rocky Mountain Prairie Region
Suite 900, 1860 Lincoln St., Denver CO 80203

FROM: William F. Sharp Jr.
(a farmer of Adams County)
Rt. 3, Box 7A
Brighton CO 80601

Dear Sir:

This letter is my comment on the sludge drying facility proposed for Adams County location by Metro Sewage Disposal Dist. #1.

Recent emotional attacks made by Adams County officials and by Town of Brighton officials are not responsive to the facts of the proposal and are damaging to the welfare of both their constituencies.

Adams County, although heavily urbanized in its extreme west and southwest areas, still remains largely an agricultural county. The environmental impact statement issued by Metro Sewage District concerning their proposed facility is conservative in its estimation of agricultural benefits and is cautious about chemical and organic problems which may limit the agricultural uses of the product.

I have had the opportunity to use digested sludge furnished by the Sewage District on an irrigated hay meadow (sprinkler irrigation) on my farm. Actual comparison of yields between cow manure fertilizer and sludge fertilization of this field shows almost unbelievable benefits from the use of sludge. The hay yield, with the use of sludge, was over 3 times the hay yield after the use of cow manure. Odor problems were non-existent during and after the application of the sludge. My home is within 200 yards of the hay field where the sludge was used.

I hired Brooks Laboratories (a recognized firm of agronomists) to analyze my soil and submit a written report on what was needed to bring the soil to its optimum productive capacity. The agronomists of Metro Sewage District found that their sludge would almost exactly furnish those elements needed by my soil and in the proper amounts by regulating the application rate. I am presently feeding the sludge fertilized hay, and it is a superior grade of feed. My animals eagerly eat it and are remaining in excellent condition. Adequate irrigation will prevent the accumulation of heavy metals in my soil according to tests made by the District on their own experimental farm.

During the experimental phase of the sludge program the economic cost of the use of sludge is, of course, much less than the cost of either commercial (manufactured) fertilizer or natural cow manure. Even when

full costs of production are included in the fees charged for sludge, the greatly increased yields will make sludge the most economical fertilizer.

My experience with this material convinces me that the hay and cattle production capabilities of Adams County would be substantially enhanced by the location of the sludge treating facility in our county. The resultant availability of a superior fertilizer without the cost of long distance transportation would also reduce the cost of hay and cattle production. The importance of economical food production to our economy cannot be overstated. The simultaneous benefit of cheap disposal of what has been a troublesome waste product makes the District's proposal irresistible.

Sincerely,

William F. Sharp Jr.

William F. Sharp Jr.

WFS/es

CC: Mr. Bill Martin
Metro Sewage Disposal District #1

EPA Response

Mr. Sharp's letter does indicate the positive agricultural benefits that can be achieved from using sludge. Personal experience with sludge applications appears to be the best way to convince others of its potential value.

Letter #5

Department of Local Affairs
Colorado Division of Planning
Philip H. Schmuck, Director

1876
Richard D. Lamm, Governor

November 3, 1976

Mr. John A. Green
Regional Administrator
Environmental Protection Agency
1860 Lincoln Street
Denver, Colorado 80203

SUBJECT: Draft Environmental Impact Statement
Metro Denver Sludge Management Plan

Dear Mr. Green:

Enclosed please find comments of the Colorado Division of Wildlife to the above-referenced Statement.

Very truly yours,

Charles G. Jordan
Senior Planner

Reviewed:
Philip H. Schmuck, Director

CGJ/vt
Enclosure

cc: Division of Wildlife

Letter #6

STATE OF COLORADO
Richard D. Lamm, Governor
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
Jack R. Grieb, Director
6060 Broadway
Denver, Colorado 80216 (825-1192)

November 3, 1976

Mr. Philip H. Schmuck, Director
Colorado Division of Planning
520 State Centennial Bldg.
1313 Sherman Street
Denver, Colorado 80203

Dear Phil:

The Division of Wildlife has reviewed the Draft Environmental Statement for the Denver Metro Sludge Management Plan by the U.S. Environmental Protection Agency. We have delayed our response so that our field personnel could fully evaluate the impact of the project upon wildlife resources. It is their opinion that the impact upon existing wildlife will be minimal and that the discussion on wildlife is adequate. Any program which will increase cover in the area will benefit wildlife.

We thank you for the opportunity to comment on this program.

Sincerely yours,

Jack R. Grieb

Jack R. Grieb
Director

JRG:jb
cc: E. P. Cook

EPA Response

We agree that overall wildlife impacts from the project operation will be minor. We shall discuss with the Metro District the possibility of preserving part of the relictual prairie area on the drying site.

Letter #7

JAMES L. OGILVIE
Secretary-Manager

Board of Water Commissioners
144 West Colfax Avenue Denver, Colorado 80202 Phone 222-6511
COMMISSIONERS
CHARLES F. BRANNAN, President JAMES B. KENNEY, JR., 1st Vice-President
WILLIAM G. TEMPLE JOHN A. YELENICK RICHARD S. SHANNON, JR.

22
1828

October 19, 1976

Mr. John A. Green
Administrator, Region VIII
United States Environmental
  Protection Agency
1860 Lincoln St.
Denver, CO 80203

Dear Mr. Green:

Thank you for the opportunity to comment on the draft Environmental Impact Statement, "Metro Denver Sludge Management Plan." The Denver Water Department's staff has reviewed the draft statement and we generally find the district's proposed action to be an environmentally sound approach to the sludge management problem.

The quantity of water used to transport sludge is mentioned in the summary, Table B, page 16, and in the text, pages 54, 91 and 112. It is stated on page 112 that "...the Denver Water Board is the owner of the water transferred from the western slope and will presumably allow Metro to use these additional waters as part of the treatment process." The Board is indeed owner of these return flows. The matter of use, however, is presently under review and discussion with the Metro staff.

Again, thank you for the opportunity to comment.

Sincerely,

J. L. Ogilvie
Manager

JLO/em

EPA Response

EPA raised the issue of the potential water rights impact and impact on downstream users as a result of increased consumptive use of water in the new sludge process. This letter is critical because the waters involved are under the control of the Denver Water Board. This letter does not indicate any concern on the part of the Board as far as increased use is concerned. This issue is discussed in greater detail under Issue I-3.

Letter #8

Metropolitan Denver Sewage Disposal District No. 1

MARY B. O'DELL, Chairman
ALAN L. CANTER, Secretary
BORIS S. VOUKOVITCH, Treasurer
WILLIAM E. KORBITZ, P. E., Manager

3100 EAST 60TH AVENUE
COMMERCE CITY, COLORADO 80022
TELEPHONE 303 289-5941

October 14, 1976 Ak. [illegible]

Mr. James W. Sanderson
Regional Counsel
U.S. Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Sanderson:

Enclosed is a copy of a letter received from Harold V. Cook, Denver Manager of Public Works, in which the status of Denver controlled Lowry Bombing Range land is set forth.

You will recall that at the time of the public hearings on the Metro District Sludge Drying Basin Project Environmental Impact Statement a number of individuals suggested that the drying basin facility should be placed on the 2,600 acres of Lowry Bombing Range under the control of the City and County of Denver. It should be obvious that such land will not be available to the Metro District for sludge drying purposes.

You are requested to make this information a part of the record of the Environmental Impact Statement procedure, or at least considered in the final Environmental Impact Statement to be issued by the U.S. Environmental Protection Agency.

Sincerely,

William E. Korbitz

William E. Korbitz, P.E.
Manager

Enclosure

cc: William J. Martin
    William H. Page

WEK/j

CITY AND COUNTY OF DENVER

W. H. McNICHOLS, JR.
Mayor

DEPARTMENT OF PUBLIC WORKS

OFFICE OF THE MANAGER
CITY AND COUNTY
BUILDING
DENVER, COLORADO 80202

October 12, 1976

Letter #9

Mr. William E. Korbitz, P.E.
Manager
Metropolitan Denver Sewage Disposal District No. 1
3100 East 60th Avenue
Commerce City, Colorado 80022

Dear Mr. Korbitz:

Your request for the use of 2,000 acres of Lowry Bombing Range land for disposal of sludge from Metro District No. 1 has been reviewed and the following resulted.

The original granting of the land to Denver was based on the landfill operation, and it is presently estimated that we have twenty-five years of capacity within the 2,600 acres. Your using approximately 2,000 acres would decrease the capacity to approximately five years.

The ongoing sludge drying project is acceptable; however, any increases such as total dedication of the 2,000 acres is objectionable. We therefore deem it necessary to deny Metro District the land for a sludge drying area.

Sincerely,

Harold V. Cook
Manager

HVC:kd

EPA Response

The draft EIS discussed the possibility of using the Lowry Bombing Rarge by Metro in much the same fashion as they are currently doing. The obvious question has been raised why the Bombing Range could not be used for the proposed drying/distribution site. The issue is discussed in detail under Issue IV-1. However, the availiblity of the site is a critical point in this discussion; the Manager of the Denver Public Works Department has indicated here that use of the greater portion of the city-owned land, which is 810 ha out of 1048 ha [2000 acres out of 2600] would eliminate the longevity of the present Denver landfill.

Letter #10

ADAMS COUNTY

ADMINISTRATION BUILDING
450 SOUTH 4TH AVENUE
BRIGHTON, COLORADO 80601
[illegible]

BOARD
OF
COUNTY COMMISSIONERS

COMMISSIONERS
John G. Campbell
Pete M. Mirelez
James M. Covey

COMMUNITY DEVELOPMENT DIVISION
Planning Department

June 17, 1976

Mr. John A. Green, Regional Administrator
Environmental Protection Agency
1860 Lincoln Street
Denver, CO 80203

Dear Mr. Green:

Adams County is currently in the process of developing a General Aviation Airport Site Selection and Master Plan Study which has identified two primary alternative sites in the very near vicinity of the proposed Metropolitan Denver Sludge Management Plan Drying Beds. A potential problem of birds being attracted by flies and other insects breeding in the drying beds has arisen as an environmental concern. The preliminary draft of the Denver Sludge Environmental Impact Statement indicates that some sort of controls would have to be developed if a vector problem should develop. Unfortunately, this does not provide us with adequate information as to what impact could develop for aircraft.

It is requested that EPA provide us with any information they may have on bird/insect problems at similar sludge drying facilities and particularly, what could or would exist at the proposed site in Adams County. As our site selection process is rapidly approaching a recommended site, we would appreciate any input you may be able to provide.

Sincerely yours,

Robert N. Fleming
Planning Director

JN:hj

EPA Response

This item is discussed under Issues II-9 and II-10.

Letter #11

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 17107, Denver, Colorado 80217

August 5, 1976

Mr. John A. Green
Regional Administrator
United States Environmental Protection Agency
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Green:

Thank you for sending us a copy of the draft Environmental Statement for the Metro Denver Sludge Management Plan. We have reviewed the document and submit the following comments:

1. We suggest the section dealing with description of the proposed action be placed as Section II of the EIS. It appears illogical to discuss alternatives and environmental setting before the reader knows what action is proposed.

2. A map of the proposed project should be added to Section IV (Fig. A from the Summary). It is difficult for the reader to jump back and forth to orient the elements of the proposal.

3. Page 91 (Description of the Proposed Actions). The description of the Sludge Transport System appears inadequate. Is the pipeline to be buried or above ground? How much land will be required for the right-of-way? Where is the intermediate pump station located and what size area will it occupy? What roads, streams, utility lines, etc., will be crossed by the pipelines?

4. Section III - Environmental Setting. This section presents environmental descriptions for the broad study area, but includes practically no specific site information for the areas to be physically impacted by implementation of the proposed action—the pipeline rights-of-way, the intermediate pumping station, and the sludge drying and distribution center. In Appendix E, site specific descriptions appear for the AMAX mine, and Lowry Bombing Range, but not for the sites to be directly impacted by the primary facilities. We believe specific information is necessary if the physical impacts are to be evaluated.

5. Section V - Impacts. We find the information in this section insufficient to evaluate the primary physical impacts to the land resulting from implementation of the proposal. Emphasis appears to be wholly on secondary impacts resulting from use of the sludge material after it is produced. From Section III, page 72, for example, we know the site

Continued next page

EPA Response

1. The organization of this EIS follows the approach EPA has developed in its regulations for environmental impact statement preparation. The idea of having an alternative discussion before the actual project description is to define the problem and possible approaches to solving it before the most acceptable choice is explained. Chronologically, we believe that this approach more closely reflects the actual course of events. Since the municipal client in the PL 92-500 wastewater treatment grants program prepares the plan well in advance of EPA approval, much of the alternatives development is done in advance of the actual project choice.

2. A more detailed map (Figure A of the Summary) will be added to Section IV of the final EIS, Volume I.

3. Answers to these questions can be found in discussion under Issues I-2 and I-4.

4. See Issues II-1 and II-8.

5. Again, see Issues II-1 and II-8 and also II-9.

Letter #11, continued

for the sludge processing site is rural and that some of the site and adjacent land is used for pasture and dryland farming. The impact to land use on page 126 is described as compatible with surrounding land use. There is no specific information or impacts presented. How much cropland, pasture, etc., will be lost along the pipeline route and facility sites and for how long? What is the present productivity in terms of crops and AUM's of grazing? What is the economic value of products lost?

These same comments apply to Section VI.

6. Summary.

The obvious weakness throughout the EIS is failure to present specific information concerning the sites upon which the system will be constructed.

This weakness occurs continually from description of the proposal and environmental settings through impacts.

We suggest more site specific information be included in the final statement.

We appreciate the opening quotation from Hugo's *Les Miserables* — very appropriate.

Sincerely,

M. D. Burdick
State Conservationist acting

cc: Council on Environmental Quality (5 copies)
R. M. Davis, Administrator, SCS, Washington, D.C.
Office of the Coordinator of Environmental Quality Activities,
Office of the Secretary, USDA, Washington, D.C.

EPA Response

6. We appreciate the comments on the draft EIS from Soil Conservation Service. We are somewhat perplexed by the lack of SCS comment on any sludge use issues.

Letter #12

FEDERAL ENERGY ADMINISTRATION
REGION VIII
1075 South Yukon
P.O. Box 26247, Belmar Branch
Lakewood, Colorado 80226

August 18, 1976

Mr. John A. Green
Regional Administrator
Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80203

Dear Jack:

The Federal Energy Administration Regional Environmental Specialists have reviewed the Draft Environmental Impact Statement (Draft-EIS) on the District Sludge Management Plan dated May, 1976. The FEA would like to submit the following comments on your proposal:

A. We concur that alternative two, with site B-2, is the ideal choice, based upon the information reviewed, with alternative seven as a possible backup. It is felt alternative two is the best suited choice for the following reasons:

1) If built as planned, the project will require no external energy resources except electricity for pumps and general in-house use, and some petroleum for dried sludge removal stockpiling and miscellaneous use. All process heat, according to the Draft EIS, will be provided by methane produced in the anaerobic digestion process.

① 2) It appears economically sound, since the system will not be dependent upon inflationary fuels and chemicals except for those mentioned above.

3) Slurry pipelines, according to most studies, are extremely energy efficient and definitely will produce major energy savings by their utilization.

4) It will provide a valuable product for farm use, and if marketing conditions slow down, will provide injection fertilization for lands owned by the city. These fertilizer products could effectively save thousands of barrels of oil by replacing petroleum-derived fertilizers.

Continued next page

EPA Response

① We are in general agreement with the FEA as to the positive aspects of the proposed project. Point # 4 under A. indicates that the sludge product will be available for injection fertilization by the city. As currently planned, only dried sludge will be available, and it will either be distributed to private or municipal users, or else buried at the Denver landfill. This does not detract from its potential usefullness as an energy-saver.

Letter #12, continued

B. The following questions are ones concerning FEA:

② 1) Site B-2 appears ideal for creating less potential citizen objections, but considering energy and economic aspects, more thought might be made in locating the plant closer to the sanitation treatment facilities, especially if it can be demonstrated the operation will emit little or no odor. In any event, any site chosen will likely be surrounded by housing projects in the future, so even B-2 can be expected to create some objection by developers.

③ 2) The treated sludge, according to your report, will contain a rather high concentration of heavy metals. These will be found in compound form, with many being water soluble; consequently, what degradations can be expected on surface waters and ground waters in the injection and drying areas? The classic example in this area is the Rocky Mountain Arsenal Lake "F" that has from time to time caused contamination of surface waters and ground waters.

④ 3) The sludge could have a high sand content. How will slurry lines and pumps be built to keep mechanical abrasion to a minimum? What backup system will be available if slurry lines do need repair?

⑤ 4) According to your figures, the sludge will have a rather high pH. Is there any plan to possibly reduce this pH to make the sludge more useable in areas already experiencing high alkaline salt problems?

⑥ 5) The system seems ideal for moderate weather conditions. What provisions are being considered to dewater during periods of freezing weather?

⑦ 6) Have there been any long-range studies regarding sludge injection in winter months? If injection use proves limited for winter use, what alternatives have been proposed to dispose of the sludge?

The FEA is extremely interested in systems such as this one that are, for the most part, energy efficient and produce a useable byproduct. When one considers the many commercial fertilizers produced from petroleum products and the finite future of these products, it is encouraging to see processes being planned that potentially could save thousands of barrels of petroleum and still provide a valuable replacement product.

Thank you for the opportunity to comment on this fine draft statement.

Sincerely,

Dudley E. Faver
Regional Administrator

cc: Dr. Robert Stern (HFEA)

EPA Response

② A discussion of alternative sites is discussed under Issue IV-1. It is not possible to guarantee that there will not be some odors from the project operation.

③ Generally, heavy metals are sparingly soluble. They are also highly exchangeable on clay soils. pH is also critical in determining the solubility of metals. The locally alkaline soil pH tends to favor precipitation of most heavy metals. In general, we expect most of the heavy metals to remain bound up in the top layer of soil when applied. See discussion under Issue I-1 and V-1.

④ Metro has indicated that they expect no problems with sand in the digested sludge (Reference 1). Sand and grit have never been excessive in Metro sludge, and grit removal units will remove any potentially harmful quantities of this material before it is pumped. The sludge transport system will consist of one 12 inch and one 10 inch pipeline with four pumps at both a main and booster pump station. Crossover valves at various points along the route will allow segments of either pipeline to be used while repairs are being made on the other line; similarly, two of the four pumps at each station have sufficient capacity to handle the entire sludge flow in case the other two pumps need servicing or replacing.

⑤ The presently disposed sludge at the Lowry Bombing Range does have a high pH (11-12). This however, is done because of the effectiveness of using high pH's from added lime to kill pathogens. The pH of anaerobically digested sludge will be closer to a neutral pH; this sludge is what will be applied to area croplands after being dried and stockpiled.

⑥ The system is designed to allow for sufficient storage capacity during winter weather, so that winter drying will not be necessary. The design assumes a 9-month drying period. During the winter, sludge will simply be pumped and stored on site. There will be some occasional drying even during this period, however.

⑦ No attempt will be made to inject sludge during the winter months. Metro will have a research and demonstration area on site; they could investigate this possibility, if there is some interest.

Letter #13

United States Department of the Interior
GEOLOGICAL SURVEY
Box 25046
Denver Federal Center
Denver, Colorado 80225

IN REPLY REFER TO:

Mail Stop #415

Water Resources Division
Colorado District

August 27, 1976

Regional Administrator
U.S. Environmental Protection Agency
Rocky Mountain Prairie Region VIII
Suite 900
1860 Lincoln Street
Denver, Colorado 80203

Dear Sir:

After reviewing the draft environmental impact statement for the Metro Denver Sludge Management Plan we concur with the information and conclusions presented with regard to the water resources of the areas discussed. The U.S. Geological Survey has been working at the Lowry Bombing Range disposal area in cooperation with the Metropolitan Denver Sewage Disposal District in order to assess the effect of waste disposal activities on ground-water quality. Our findings agree with those presented on pages 170 and 171 of the EIS. The EIS correctly emphasizes the importance of ground-water quality monitoring in areas which may be adversley affected by recharge of sludge leachate.

Sincerely,

FOR THE DISTRICT CHIEF

Stan Robson

EPA Response

Data from the CH2m-Hill Geotechnical and Soils Report has recently been made available that supplants the information about Site B-2 mentioned on pages 170-171. The resolution of the groundwater issue is found under Issue II-2.

Letter #14

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGION VIII
FEDERAL OFFICE BUILDING
19TH AND STOUT STREETS
DENVER, COLORADO 80202

August 30, 1976

OFFICE OF THE REGIONAL

Mr. John A. Green
Regional Administrator
Environmental Protection Agency
1860 Lincoln Street
Denver, CO 80203

Dear Mr. Green:

Thank you for the opportunity to review the draft Environmental Impact Statement (EIS) for the Metro Denver Sludge Management Plan.

It appears that the impacts expected to result from the proposed project and reasonable alternatives thereto have been adequately addressed.

Sincerely yours,

for Rulon R. Garfield
Regional Director

cc: Office of Environmental Affairs,
HEW, Washington, D.C.
Council on Environmental Quality
Washington, D.C. (2 Copies)

EPA Response

No comment

Letter #15

MRS. RONALD D. WARNER
BENNETT, COLORADO 80102

September 1, 1976

Regional Administrator
U.S. Environmental Protection Agency
Rocky Mountain-Prairie Region VIII
Suite 900
1860 Lincoln Street
Denver, CO. 80203

RE: Metro Denver Sludge Management Plan

Gentlemen:

Can it be that the nightmare we have been living with since November,1972 is about to come to real life?

We have spent hours and hours attending meetings, made numerous phone calls, written letters, made personal contacts, and have friends and relatives, and a few strangers, too, from New York to Colorado and points North and South apprised of a system for re-cycling sewage sludge by inundating 2,000 acres of healthy, producing agricultural ground.

Although it is difficult to limit our reaction to the statement of facts, the statistics, the studies, diagrams, etc. involved in the Environmental Impact Study recently issued, our comments will be summarized in a few short statements.

Considering we are landowners in the projected site, and also are part of the residents most directly involved, we feel we must object to the location, as well as the method of this project. Not only because it directly involves our welfare, but the community in general.

① As the draft E.I.S. states, "the E.P.A. recognizes there is certain amount of risk involved in terms of the "success" of the project...". We are most unwilling to acknowledge this as anything but an unproven, or at best, poorly proven method of re-cycling sludge. There are other systems such as the Swedish method, and the one currently used in Milwaukee, Wisconsin that are successful and do not require the taking of agricultural ground. ② Until the method is proven, why not continue using ground now set aside for similar usage on the Lowry Bombing Range, or that already useless land at the Rocky Mountain Arsenal?

③ The Summary of Impacts, Figure 16, page 136, should have enough negative impacts (whether a "rough ranking or not) to make the project meet with failure.

④ Also, may we remark that although you consider this site of little historic value, Appendix G, page G-3, the "other resident" involved in being displaced is one of the last homesteaders of this area of Colorado who still maintains his home on the farm at 86 years of age. He is a member of the

Continued next page

EPA Response

① A discussion on research need surrounding this project is found under Issue II-11. Other alternative systems, including the "Swedish method", are found under Issue IV-3.

② The issue of using the Lowry Bombing Range and the Rocky Mountain Arsenal is discussed under Issue IV-1.

③ It is not possible from the figures developed in the EIS to summarize impacts (e.g., Figure 16), or to make a judgment about the overall merits of the project. The negative impacts stand out because they are identified and discussed in detail. Positive impacts may be wide-reaching but are mentioned only once. These figures were never intended to summarize the overall impacts; they are there to alert the reader to impacts and issues that are by themselves considered "important".

Letter #15, continued

④ Colorado Archeological Society and has for years maintained an interest in the history of the area. He has valuable arrowhead collections obtained from the the lands bordering this site and shares his knowledge and background with all. He, indeed, is part of the history of the area.

⑤ We have lived here well over 20 years, and have always gloried in the wide open spaces surrounding us. We do not feel isolated or abandoned by society. City people have often asked for permission to walk across our fields just to enjoy the feeling of openness it gives them. This could well be established, and more to the benefit of the County, and State, as an "open space area".'

In closing, we note your E.I.S. takes advantage of quotes from Victor Hugo... we would like to quote from the dedication of a book entitled "Our Side of the Mountain" written by a local resident, Emma Michell, who has earnestly worked to preserve the aesthetics and history of this area of Colorado.

> "....to the pioneers who had the foresight and stamina to endure the hardships necessary to establish and preserve a heritage for this and future generations."

Is this what is to be covered with sludge?

Sincerely,

Lillian M. Warner

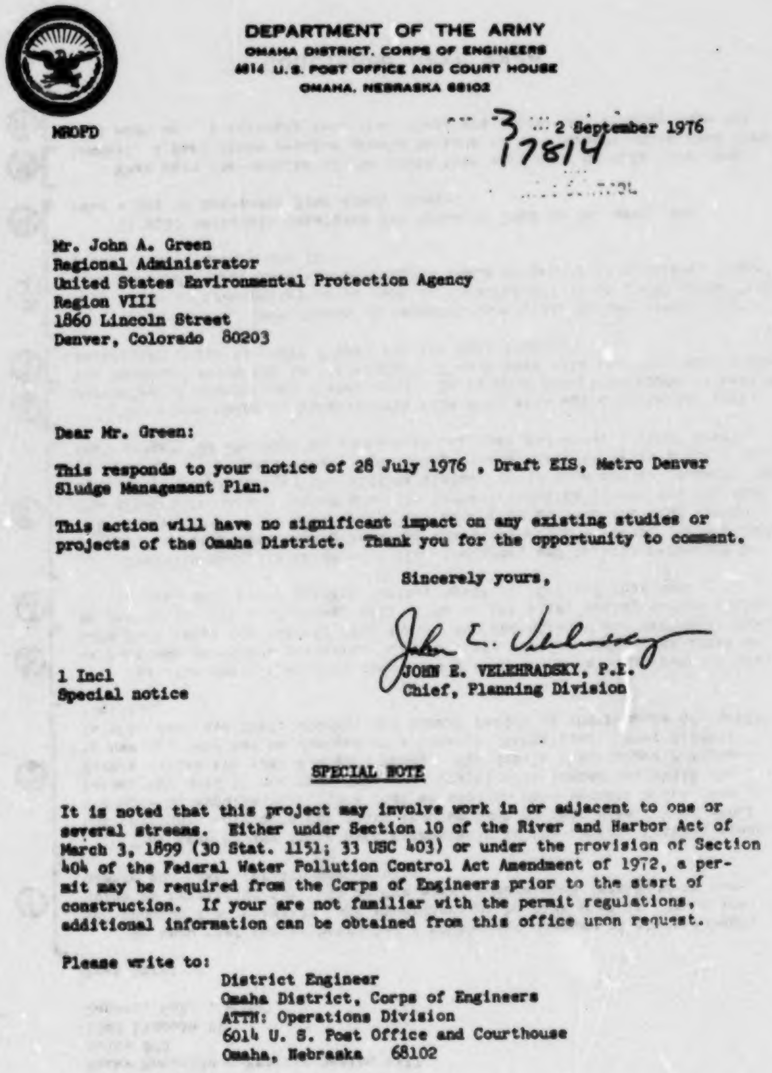
Lillian M. Warner
(Mrs. Ronald D.)

EPA Response

④ The point on historic resources in Appendix G, page G-3, simply compares this site with other sites. We doubt the surveyors were aware of the presence of the homesteader you refer to. This resident still has the right to object to the present evaluation of archaeologic and historic resources in the area.

⑤ Although there will be occasional odors, the nature of the operation will be such that there should be very little change in land uses in the site vicinity.

Letter #16



DEPARTMENT OF THE ARMY
OMAHA DISTRICT, CORPS OF ENGINEERS
6014 U.S. POST OFFICE AND COURT HOUSE
OMAHA, NEBRASKA 68102

MROPD

3 2 September 1976
17814

Mr. John A. Green
Regional Administrator
United States Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Green:

This responds to your notice of 28 July 1976 , Draft EIS, Metro Denver Sludge Management Plan.

This action will have no significant impact on any existing studies or projects of the Omaha District. Thank you for the opportunity to comment.

Sincerely yours,

John E. Velehradsky
JOHN E. VELEHRADSKY, P.E.
Chief, Planning Division

1 Incl
Special notice

SPECIAL NOTE

It is noted that this project may involve work in or adjacent to one or several streams. Either under Section 10 of the River and Harbor Act of March 3, 1899 (30 Stat. 1151; 33 USC 403) or under the provision of Section 404 of the Federal Water Pollution Control Act Amendment of 1972, a permit may be required from the Corps of Engineers prior to the start of construction. If your are not familiar with the permit regulations, additional information can be obtained from this office upon request.

Please write to:

District Engineer
Omaha District, Corps of Engineers
ATTN: Operations Division
6014 U. S. Post Office and Courthouse
Omaha, Nebraska 68102

EPA Response

We shall inform the Metro District that a Section 404 Permit should be applied for. There may be some question whether a Section 404 Permit would apply, since these streams adjacent to the site are intermittent and normally contain no flow.

Letter #17

Regional Administrator
U.S. E.P.A.
Rocky Mountain - Prairie Region VIII
Suite 900
1860 Lincoln St.
Denver, Colo., 80203

Dear Sirs:

① We know that Denver Metro has a problem to dispose of their sludge; but shouldn't more testing and experimenting be made with it, as to its value as fertilizer for this entire area, before good farm land is condemned and taken for its drying pits.

② They keep saying it is used extensively in the London, Chicago areas, but they have more moisture there than we have in this area. What about a couple of experimental plots that we made in this Bennett area? The farmer who used it one year, his crop practically burned up, while the farmer across the road had good wheat. Why didn't that farmer continue to use it? Why has he changed to a chemical fertilizer? Most farmers in this area use their stubble and summer fallow as their means of fertilizing.

③ The area which they have chosen to dry it in has a large run-off when
we have any excessive moisture. Come out and see for yourselves after we
have hard rains and run-off from snow. See the ditches and washes it makes
④ on the land. How much damage will it do to the water basin, to the wells
in the area and to the farmers further north as it flows that way.

⑤ There is bound to be an odor from the area, and it will certainly be carried to other surrounding areas by the winds which we have. Before Barr Lake was cleaned up we could smell the odor from it when the wind was in the right direction. I live near the Bennett settling pounds and the odor from it is terrible when the wind is right. It is supposed to be water controlled and is a small area. The drying pounds there of Metro's would be much larger, so the odor would be much stronger and cover a wider area.

⑥ The winds which we have in this wide open area would certainly carry
particles of sludge over a wide area. Do we have enough moisture to handle
⑦ the minerals which are in the sludge? I have been told that too much sludge
fertilizer helps to shall I say, run the soil together.

⑧ The area they have chosen is certainly not close to any markets, or very close to transportation to take it to markets. It is 15-20 miles from a market and rather poor transportation means to get it to a market. Dryland is not a market for it.

⑨ It will certainly devaluate the value of land in the area, and take a lot of tax-money from Adams County.

⑩ What were the results of the tests that were made on this land this
summer? I feel those results should be made to the farmers whose land they
⑪ were made on. I strongly feel that there are better and cheaper ways for

Continued next page

EPA Response

① A discussion of research need surrounding this project, and the level of uncertainty involved is found under Issue II-11.

② The tests referred to in this letter were made in 1973-4 on dryland farm areas. The tests results indicated that there were significant benefits to utilizing sludge, as well as a considerable uptake of heavy metals. These tests and their results are discussed in Issue IV-1. Metro's present position is that because of the low nutrient requirements on dryland areas, Metro sludge will probably not be used to any great extent on dryland farm areas.

③ Wholesale runoff including sediment could move undesirable metals and pathogens into local streams on dryland areas. However, Metro's preferred agricultural areas would be with irrigated farming, where tailwater control on irrigated lands is likely to be practiced, or at least where mild slopes would not pose such a runoff hazard.

④ Shallow aquifer (alluvial) wells could conceivably be affected by leachate from the drying site itself. EPA will therefore require lining of the basins to minimize leachate movement (see discussion on Issue II-2).

⑤ Odors from the site are discussed under Issue II-3.

⑥ Airborne transport of sludge at the site is discussed under Issue II-5.

⑦ This letter indicated information to the effect that sludge applications would cause soil clogging. EPA's best information is that applied dry sludge generally has the opposite effect; i.e., that the organic material added to the soil increases soil porosity as well as water retention.

⑧ This issue of sludge marketability and distance from markets is discussed under Issues II-14 and V-4.

⑨ See Issue II-4 on the question of land values.

⑩ The tests performed on site B-2 during the summer of 1976 were to collect soils, permeability and structural engineering information. CH2M-Hill, the consulting engineers for Metro, have prepared a Geotechnical and soils Report containing this information. Much of the relevant information is discussed under Issue II-2, on groundwater impacts at the site.

Letter #17, continued

⑪ Metro to dispose of the sludge than to use it for fertilizer.

⑫ How can the drying pits help but contaminate the water, the air and the surrounding environment? They have a long lease on the bombing range, why not continue to transport it there?

⑬ Where are they going to get the water to bring it to this chosen site? There are no irrigation wells in this area, which would help them.

I have lived and farmed in this area for 35-40 years. We have enjoyed life in this area. I can certainly say I hate to see part of our good farm land which we have owned for almost that whole time, taken and used for this purpose.

Yours truly,

/s/ Catherine M. Mundell

EPA Response

⑪ Recycling of sludge for agricultural use is probably the most economical way to process sludge, if the difficulties can be resolved. Chapter II in Volume I of the EIS demonstrates the cost-effectivness of this approach.

⑫ Problems with the present operation at Lowry Bombing Range are discussed under Issue III-1. This system could continue, but is expensive and has no agricultural benefit. The use of Lowry for the proposed operation is found under Issue IV-1.

⑬ Metro proposes to construct a small well at the site for potable use. Water for irrigation and research will be pumped occasionally to the site and stored in the irrigation impoundment (see Figure 12, Volume I, Chapter IV). This water is needed to occasionally purge the sludge transport lines. Water impounded on-site during rainfall events will also be pumped back to the reservoir.

Letter #18

TYPED FROM HANDWRITTEN LETTER.

September 6, 1976

United States Environmental Protection Agency,
Region VIII,
1860 Lincoln Street,
Denver, Colorado, 80203.

Dear Friends,

This letter is written in regard to Denver Metro Sewage District's
proposed plan to pipe and dry their sewage on a 900 acre site in Adams
County. Being a farmer near this area, I have serious reservations on
how this would or could jeopardize our daily lives and ultimately our
① future for continuance in farming in this area. I, as well as many other
farmers, are not enthusiastic to have an unproven experiment of this
size thrust into our area which as you well know is subject to dry
weather and wind erosion. Also, with Denver's rapid growth now and in
② the future, we fear that the proposed 900 acre site would shortly become
inadequate and the outward expansion in this area would mushroom despite
Metro Sewage's past promises that 900 acres would be all they need.

I will not take more of your time but will ask for your fair and honest consideration of our problem - thank you!

Sincerely yours,
Donald A. Wailes
Box 156
Strasburg, Colorado 80136

EPA Response

① The issue of wind erosion at the site is discussed under Issue II-5.

② Capacity of the proposed system is found under Issue II-12.

Letter #19

Rt.1 Box 25
Bennett, Colo. 80102
September 7, 1976

Regional Administrator
U.S. Environmental Protection Agency
Rocky Mountain - Prairie Region 8
Suite 900
1860 Lincoln Street
Denver, Colo.

Dear Sir:

I am writing in regard to the proposal of Metro Sewage District of buying private land in Adams County to try out their sludge drying and selling idea.

As I reside within one mile of the proposed site, I am opposed to the purchase of the land for the following reasons.

① I question Metro's need to take private land when they have not thoroughly investigated the possibility of using the bombing range. The private land in question is productive farm ground which will be difficult to replace by the individual land owners.

② Secondly I feel your report brings up the serious question of possible contamination of the underground water supply. At the present time the water in the basin is safe for human consumption, but will it remain so if the sludge is placed there as Metro plans ? As you pointed out in your report, it is a closed water basin that affects a large area.

③ Thirdly I feel that since this is a pilot program, more research needs to be done to prove that sludge can be used by dry-land farmers, and if it will be used by them in wahat amounts.

④ In your report you also state the possible bad effects on certain broad leaf plants. You also state that turf farms will be big users, but the area selected is in the middle of dry-land farms which tolerate only a minimum of fertilizer. The nearest turf farm is approximately 20 miles away, and it is a small one.

I believe there is insufficient evidence to prove that dryland operators are going to eagerly buy the district's products.

I feel that the district should attempt to develop this product on the bombing range, then if there is a market select a site which will be centrally located to the major users.

⑤ I also question the effect the drying and stockpiling

Continued next page

EPA Response

① Use of the Lowry Bombing Range for this project is discussed under Issue IV-1.

② Potential groundwater contamination at the site is covered under Issue II-2.

③ Experimental nature of the project is covered under Issue II-11.

④ Market distance is evaluated under Issue II-14. No one site can be close to both the turf farms in the northeast Platte River area and the area along Cherry Creek.

Letter #19,
continued

⑤ site will have on the immediate area surrounding it. Your report raises a question about the effect of wind on the dry sludge. Since the proposed site is known to have windy conditions in winter and spring, I believe this will be a definite problem. ⑥ I also know there will be an odor problem. There is sufficient evidence to back this up from other areas where sludge is being used and applied to the ground.

⑦ I question the amount of research done to eliminate Ascaris and metalic residues in the finished product. In your report you state it may take up to three years to kill Ascaris. I believe Metro's own reports will indicate the pathogen studies have not been sufficient.

I believe there are enough areas open to question for the EPA to withhold funding for this particular project, and that more planning and research needs to be completed by Metro before they are allowed to purchase private land for this project.

Sincerely,

John Mundell

EPA Response

⑤ Windblowing of dried sludge is covered under Issue II-5.

⑥ Odor problems are discussed under Issue II-3.

⑦ Heavy metals control at the source is discussed under Issue I-1. Risks from pathogens from sludge use is discussed under Issue V-1.

Letter #20

17873

September 9, 1976

Regional Administrator
U.S. Environmental Protection Agency
Rocky Mountain-Prairie Region VIII
Suite 900
1860 Lincoln Street
Denver, CO. 80203

RE: Metro Denver Sludge Management Plan

Gentlemen:

Having read the Draft E.I.S. I feel a distinct need to relay my feelings about this proposal.

I reside appox. 5 miles northeast, of Site B2 my residence here began 47 years ago, taking an active intrest in community affairs I have become quite familiar with this area.

① I have attended all public meetings held by "Metro" tryed to comprehend the printed material they have supplied. I have served on the Citizens Advisory Committee for over two years, missing only one meeting last July 19. However my name is omitted from your list pages 199-200. I am flattered Metro would omit a member with the probable best attendence.

In my conversations with Metro personnel, they have convinced me they are faced with a monumental problem, I concur completly with the intent to turn negative to positive action. However to move a problem to a different location is not a solution, Metro research at this time does not justify this project there are to many unresolved items, too little dedicated consederation.

② Site B2 is predominantly located in a closed water basin, I am sure you realize the unique problems in this kind of area, without a project such as Metro proposes.

③ The location is not energy efficient considering the distance from the Commerce City facility and in the opposite direction from the market for this marginal product.

Continued next page

EPA Response

① Based on our reading of the Advisory Group attendance records, we are certain Metro's omission of your name was inadvertent.

② The issue of goundwater contamination and the "closed basin" under the site is covered under Issue II-1 and II-2.

③ Even given the distance of site B-2 from the potential users, the proposed system is still more energy efficient than the present method of operation and other alternatives. Also, see letter from Larry Brown, AMAX Mining, on economics of hauling sludge (Letter #1). See Issue II-14.

Letter #20, continued

Page 2

Regional Administrator
U.S. Environmental Protection Agency

④ Forced aquisition of private owned land in a state that is one half public owned, Lowry Bombing range is about equal distance as site B2, another the Rocky Mountain Arsenal, either or both of these locations could and should be used in a concerned and dediciated research program to prove the worth of the project as to the safety of the surrounding area, value and market of this proposed operation.

5 The total loss to the Adams County area will not be measured by the 2,000 acre site and we have no assurance more land will not be condemed at a future date, the greater loss will be the devaluation of the surrounding area, witness Draft E.I.S.

⑥ Figure 16 page 156. In regard to this summary I disagree with the low rating given air quality also no mention of wind movment of dried material.

⑦ Metro management has acknowledged their first proposal would have been a complete disaster, if the Adams & Weld county residents had not resisted, that project would have been instituted several years ago. I sincerely believe the present proposal is lacking proof of success.

I appreciated the appearance by Mr. Ganseki at Metro's Advisory Committee meeting sometime ago, I would be pleased to meet with E.P.A. personnel at anytime.

Sincerely,

Lawrence E. Wailes

rw

EPA Response

④ Site alternatives are dicussed under Issue IV-1.

⑤ Future capacity needs are discussed under Issue II-13.

⑥ Windblowing at the site is covered under Issue II-5.

⑦ Metro's earlier proposal as presented in 1972 might well have caused problems from oversupply of nitrogen on dryland areas. Metro's present proposal is much more flexible, and even if dried sludge were to be landfill, the costs would be less than the present operation.

Letter #21

THE STATE HISTORICAL SOCIETY OF COLORADO

Colorado State Museum, 200 Fourteenth Avenue, Denver 80203

September 13, 1976

Mr. John A. Green
Regional Administrator
United States Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80203

RE: Draft Environmental Impact Statement for Metro Denver Sludge Management Plan

Reference is made to the above statement drafted by the Environmental Protection Agency.

Based on the information contained in the statement, no historical properties were found within the project area. In addition, we have reviewed the Colorado Inventory of Historic Sites and the National Register of Historic Places for information about known properties located within or near the project area; none were found in either listing that would be affected. Therefore, insofar as historic properties are concerned, the Environmental Protection Agency has met its responsibilities with respect to 36 CFR 800. The Office of the State Archaeologist of the State Historical Society will reply separately with respect to the possible existence of archaeological resources in the project area.

FOR THE STATE HISTORIC PRESERVATION OFFICER

Sincerely,

James Edward Hartmann
Curator, Historic Preservation

EPA Response

Archaeology issues on this project have been discussed with the State archaeologist. See Issue I-4.

Richard D. Lamm, Governor

Department of Local Affairs
Colorado Division of Planning
Philip H. Schmuck, Director

Letter #22

September 13, 1976

Mr. John A. Green
Regional Administrator
Environmental Protection Agency
1860 Lincoln Street
Denver, Colorado 80203

SUBJECT: Draft Environmental Impact Statement
Metro Denver Sludge Management Plan

Dear Mr. Green:

The above-referenced Environmental Impact Statement was received and distributed for review by state agencies in accordance with the National Environmental Policy Act. All responses are enclosed herewith.

The primary state concerns may be summarized as follows:

① Water quality. As discussed by the Department of Health and Colorado Geological Survey, the questions of potential aquifer pollution have not been sufficiently answered. Both agencies offer constructive suggestions for monitoring and mitigation. It should be recognized that the water quality considerations have implications on future land use plans for the area which currently foresee continued agricultural uses. Aquifer pollution would likely alter that projection, causing a loss of a valuable agricultural resource as suggested by the Department of Agriculture.

② Water resource allocation. The enclosure from the Division of Water Resources sets forth legal water use criteria which must be met. In addition, however, the draft statement inadequately evaluates the environmental effects of water resource consumption. A comment near the top of p. 112 suggests that the EIS treats only the legal constraints of water use rather than the environmental and economic impacts. In a water deficient area it is important that water conservation be a major consideration for any development proposal. Therefore we feel that the treatment of alternatives in the Final EIS should consider the alternative demands upon water use.

③ Agricultural impacts. From the comments of the Department of Agriculture, it is apparent that the EIS does not adequately weigh the positive effects of providing fertilizer and maintaining the ecological life cycle against the negative impacts of loss of agricultural land, water use and pollution, and

Continued next page

EPA Response

① See discussion on groundwater problems under Issue II-2.

② In the discussion on water rights (Issue I-3), a discussion of the aggregate environmental impacts is made. The overall impact is expected to be minor.

③ The agricultural impact expected as a result of the B-2 site acquisition is found under Issue II-8. The overall balance is also discussed here.

Letter #22,
continued

Environmental Protection Agency
Re: Metro Denver Sludge Management Plan
September 13, 1976
Page 2

③ potential deterioration of the quality of life in the community selected for drying sites. These should be objectively balanced to determine the net impact on agriculture.

④ In addition to the foregoing comments, I wish to point out that on p. 81 of the EIS, the third sentence states that the Colorado Land Use Commission has jurisdiction for managing state lands. I believe that the agency intended was the Colorado Board of Land Commissioners.

Thank you for the opportunity to comment on this proposal. I look forward to receiving a copy of the Final EIS.

Very truly yours,

Charles G Jordan
Charles G. Jordan
Senior Planner

Reviewed: ______________
Philip H. Schmuck
Director, State Clearinghouse

CGJ/vt
Enclosures

cc: Department of Health
Department of Agriculture
Colorado Geological Survey
Division of Water Resources
State Archaeologist

EPA Response

④ This correction has been made in the text.

Letter #23

COLORADO DEPARTMENT OF HEALTH

4210 E. 11TH AVENUE DENVER 80220 PHONE 388-6111

ANTHONY ROBBINS, M.D., M.P.A. EXECUTIVE DIRECTOR

September 1, 1976

Mr. Phil Schmuck, Director
State Clearinghouse
520 State Centennial Building
1313 Sherman
Denver, CO 80203

SEP 3 1976

RE: DEIS - Denver Metro Sludge Management Plan #76-132

Dear Mr. Schmuck:

The Colorado Department of Health has reviewed the DEIS for the Denver Metro Sludge Management Plan and has the following comments:

Air Pollution Control Division

① 1. It was determined that the air quality impact of the proposed project was adequately addressed in the DEIS. We would concur that the most significant emissions from the sludge drying facility would be fugitive dust and odor. Although no specific permit is required, we would recommend that a fugitive dust control plan be implemented in order to reduce these emissions to the greatest possible extent.

② 2. Standards for the emission of malodorous compounds are covered by Air Pollution Control Commission Regulation No. 2. As was stated in the document, a definitive plan for the control of malodorous emissions must be submitted to the Air Pollution Control Division for review. We would agree that the cumulative air quality impact upon the proposed project would be minimal.

Engineering and Sanitation Division

③ 1. The EIS mentions the addition of pesticides (Organophosphates) to sludge at the plant to prevent and control insect populations in sludge drying beds. Nothing was mentioned for insect control in the impoundment ponds. The report and plan should include a contingency plan for control of insects and rodents. There may be problems relative to birds feeding on insects and using the sludge ponds.

④ 2. The alternative of drying beds with underdrain systems to collect and process the supernatant was not included in the alternatives investigated. This alternative could minimize the issues of dissolved salts and heavy metals.

Continued next page

EPA Response

① EPA will require that a fugitive dust control plan be developed in the plans and specifications for this project. Metro has indicated by communication of June 9, 1977, the current plans for dust control:

> "The solids stockpile areas are provided with strategically located fire hydrants for use in wetting the solids stockpiles at time of high winds to prevent wind blowing of the material if this should prove to be a problem. Water used for this operation is that which is pumped to the drying and distribution center from the Central Plan for cleaning the transport system piplines and also runoff water collected from the drying and distribution site."

② EPA will require as a Step II and III grant condition that the Metro District submit a plan for control of malodorous emissions to the Colorado Air Pollution Control Division.

③ See discussion in Issue II-10, concerning vector control. EPA will require as a grant condition that a vector control plan be developed.

④ The alternative of using underdrains at site B-2 is costed in the discussion on groundwater quality control alternatives (Issue IV-2).

Letter #23, continued

Mr. Phil Schmuck
September 1, 1976
Page 2

⑤ 3. Dried sludge should not be applied to root crops or leafy vegetables that could be eaten raw unless the sludge has been stored for a minimum of one year.

⑥ 4. It is agreed that anaerobically digested sludge is less odorous than raw or activated sludge from municipal treatment plants. Many factors such as precipitation, temperature, wind, soil permeability, evaporation rates, can influence odor conditions. This sludge may not have objectionable odors in comparitively small amounts. However, it is difficult to predict when considering 600 acres of drying beds.

Water Quality Control Division

⑦ 1. Our one remaining concern with the plan is the proposed use of unlined drying beds. The EIS recognizes this concern also, and provides proper mitigating measures (p. 181, 182). We strongly urge that the proposed project be ammended to include impervious lining of the beds and some type of underdrainage.

2. All other elements of the project are environmentally sound from a water quality aspect.

Thank you for the opportunity to review the DEIS. Please contact us if any of our comments require clarification.

Very truly yours,

FOR DIRECTOR, WATER QUALITY CONTROL DIVISION

Jonathan Scherschligt, P.E.
Planning Engineer
Water Quality Management Planning Section

JS/mb

cc: Bob Siek
John O'Neal
Mike Gansecki, EPA

EPA Response

⑤ EPA will adopt this recommendation in its Mitigating Measures Section. Also see discussion on Sludge Use Constraints (Issue V-1).

⑥ We generally agree that with 240 ha [600 acres] of drying beds, there are likely to be occasional odors. A definite odor was noticed at the San Jose, CA drying beds with a strong wind, mostly from recently filled basins. See discussion under Issue II-3.

⑦ EPA will require lining of the drying basins to minimize leachate. See Issue II-2. EPA will also require an emergency plan to pump out groundwater in the event significant concentrations of water pollutants develop under the site. We do not think that any form of underdrainage is feasible because of costs (see Issue IV-2).

Letter #24

STATE OF COLORADO

SEP [illegible]

Richard D. Lamm
Governor

J. Evan Goulding
[illegible]
Commissioner

Donald L. Svedman
Deputy Commissioner

COLORADO DEPARTMENT OF AGRICULTURE
406 STATE SERVICES BUILDING
1525 SHERMAN STREET
DENVER, COLORADO 80203

AGRICULTURAL COMMISSION
Clarence Stone, Center
Chairman
William A. Stephens, Gypsum
Vice-Chairman
Ben Eastman, Hotchkiss
John L. Malloy, Denver
M. C. McCormick, Holly
Elton Miller, Fort Lupton
Kay D. Morrison, Fleming
William H. Webster, Greeley
Kenneth G. Wilmore, Denver

10 September 1976

M E M O R A N D U M

TO: Charles Jordan, Senior Planner
A-95 Clearinghouse
Division of Planning

FROM: David L. Carlson
Resource Information Specialist

SUBJECT: Colorado Department of Agriculture Review of the Metro Denver Sludge Management Plan Draft EIS

COMMENTS ON THE TECHNICAL ACCURACY OF THE EIS

The EIS was reviewed in depth by staff from the Inspection and Consumer Services Division of this department. In general, the technical accuracy of the document is considered to be very high. Four specific comments follow:

1. The value of the dried sludge as fertilizer (pages 122, 164 and elsewhere) may be overstated since (a) there is no present shortage of fertilizer, and (b) the cost of time, equipment and energy in applying a low analysis fertilizer vs. a high analysis commercial fertilizer is not considered. In addition, food producers using the sludge would need to comply with additional regulations of the State Department of Health and the Food and Drug Administration. The value of additional time spent in complying with these regulations (filling out forms, meeting with inspectors, etc.) should be deducted from the gross value of the sludge to obtain a net value.

2. On page 20 (Table 2), the use of sludge materials for cattle feed is considered. Under current state feed and fertilizer regulations ("Rules and Regulations Regarding Processed Animal Waste Products," Colorado Department of Agriculture Regulation No. 6-1) this is not permitted at the present time.

3. On page 82, it is stated that nitrogen fertilizer is manufactured in the state. According to our Inspection and Consumer Services Division, there is no such fertilizer production in Colorado at this time. Also, Colorado potash manufacturing is insignificant.

4. On page 84, it is stated that "the fertilizer for the agriculural economy of the state is presently in short supply..." According to the Inspection and Consumer Services Division, there is no such shortage at the present time.

Continued next page

EPA Response

1. Time has a way of making EIS's outdated; at the time of preparation of the draft EIS, an energy crisis was still a reality, and there were concerns about shortages of natural gas-derived fertilizer. For the short-term at least, this is now not a problem. EPA does agree that there is a cost associated with applying a low-grade fertilizer such as dried sludge versus a high-grade fertilizer. The discussion under Issues II-14 and V-3 discusses such added costs. We do not think that bureaucratic forms and regulations should be realistically considered in cost terms or constraints; such forms and regulations could crop up anywhere.

2. The discussion on sludge use under Issue V-1 (constraints) and V-2 (Control of applications offsite) recognizes that this is not permitted.

3. This has been corrected.

4. See comment 1. above. This change has been noted in the text.

Letter #24, continued

Charles Jordan
10 September 1976
Page 2

ADDITIONAL COMMENTS

The disposal of sewage sludge may be considered from several perspectives, including the following:

(a) disposal of undersirable materials

(b) improving water quality

(c) increasing food production; food and feed crops, grasslands

(i) application of dried sludge as fertilizer

(ii) application of wet sludge, both for fertilizer value and water content

(d) improving soil fertility in non-food applications (parks, sod farms, etc.)

(e) mined land reclamation

(i) application of dried sludge as fertilizer

(ii) application of wet sludge, both for fertilizer value and water content

(f) production of methane gas for commercial use

(g) quality of life and property values in the area surrounding the drying site

⑤ The EIS considered most directly objectives (a), (c)-(ii), (d), and (e)-(ii), at least implicity. However, to what extent is the project compatible with the other objectives listed above? More specific comments and questions follow.

⑥ (a) Improving water quality. What is the location of the drying sites in relation to groundwater and surface waters? Said another way, were the drying sites selected to minimize possible adverse effects to water quality?

⑦ (c)-(ii) Increasing food production through wet sludge application. Setting aside, for a moment, important problems affecting the potential use of wet sludge for growing crops and forage vegetation, such as heavy metals, salt buildup, pathogens, etc., what is the future potential for increased irrigation acreage near the east of Denver if maximum food production becomes important in the not-too-distant future? How many acre-feet of water per year would be available for this purpose? Where are the lands east of Denver with high inherent agricultural productivity that are currently underutilized because of a lack of water? Were the drying sites and pipeline corridors chosen with these lands in mind?

Continued next page

EPA Response

⑤ Your comment is an excellent one, although quite complex to answer. Our general response to the question you posed as to the extent of project compatability with objectives (a) thru (g), would be as follows: The project is generally intended to further these objectives with the possible exception of objective (g). In the latter case, the project is designed to minimize the negative impacts on the quality of life of persons in the site area, although there will be some negative impact. Another qualification is that there are now no current plans by Metro to market wet or liquid sludge, although this could still be done. We will also attempt to respond to your specific questions directly below.

⑥ Although the water quality and groundwater were not actively considered in the decisions about site location by Metro, it does happen that the choice of sites for other reasons turn out to be generally compatible from a water quality standpoint. For instance, locating in the dryland areas away from perennial streams minimizes the impact on surface waters. The fact that Metro selected their site based on the ability to control runoff from the site (in an upstream area of a watershed) makes control of water quality simpler. Finally, the choice of a site at a considerable distance away from shallow groundwaters in an area of generally clayey soils makes it more feasible to control leachate to the groundwater. Distance from households was a factor in this selection, and this minimizes the potential for contamination of domestic and other supply wells. EPA is also requiring additional controls to protect groundwater quality.

⑦ Because of the favorable economics of hauling sludge over fairly long distances, the distance from markets is not a critical factor. There will probably be relatively little use of the dried sludge in the site or pipeline vicinity. Metropolitan area and irrigated areas to the north will probably use the sludge in greater quantities. The selection of the pipeline route and site were made to minimize conflict with existing land uses, and not because of potential markets.

Letter #24, continued

Charles Jordan
10 September 1976
Page 3

⑧ (e)-(ii) Mined Land reclamation through wet sludge application. Denver is located on the western edge of a vast coal basin, containing large amounts of lignite. A lignite gasification plant is scheduled to be built near Watkins in the early 1980's. Presumably much of the lignite for this plant will be strip-mined. Have the lands most likely to be mined been identified? Again, were the drying sites and pipeline corridors chosen with these lands in mind?

⑨ In addition, will the drying sites take valuable agricultural land out of production? Are other less productive lands available for drying sites and pipeline corridors?

⑩ (f) Production of methane gas for commercial use. Due consideration should given to the research sponsored by the Four Corners Regional Commission regarding the conversion of biodegradable materials to methane gas. Has the production of methane gas been considered as a possible component of the sludge management plan? How many cubic feet of methane per day could be generated? In view of decreasing availability of natural gas, the production of methane gas for commercial use ought to be carefully considered.

⑪ (g) Quality of life and property values in the area surrounding the drying site. Will this project result in odor, seepage, blowing, or other unpleasant effects such as heavy traffic, burden on roads, or other facilities, which will diminish the quality of life in the surrounding area? Will these effects force surrounding farmers to flee the area? What will the effect be upon property values? Have other drying sites been considered which would minimize the loss of the valuable rural setting or agricultural economy of the area?

SUMMARY

The Colorado Department of Agriculture strongly supports the responsible management of sewage sludge for a wide range of beneficial uses. Although several significant problems must be contended with, we encourage continued efforts in research and management to utilize the nutrient content of sewage wastes resourcefully. However, we urge that a wide range of current and potential uses be considered in the design and operation of a specific management plan such as the plan submitted by the Denver Metro Sewage District. Specifically, we request that the location of the drying sites and pipelines be reviewed from a food production, water quality and quality of life perspective to obtain maximum benefit from this forward-looking project.

DLC/pjc

EPA Response

⑧ The site was not chosen with lignite mining in mind. However, the Watkins strip mine/gasification proposal does appear to be an ideal location to be serviced by Metro sludge both for land reclamation and perhaps even in the gasification process itself.

⑨ See dicussions under Issues I-2 and II-8.

⑩ The digesters recently constructed at the Metro District plant do have gas burners to utilize a portion of methane generated in the digesters for heating the digester contents. Optimum performance of digesters can be achieved by maintaining fairly close temperature limits on digester operation. Metro considered the use of the excess methane gas for electrical generation, but found that the costs of the conversion equipment were prohibitive. Therefore, some of the excess gas is wasted, although during the winter, most will probably be used to maintain the digester temperature.

⑪ There will be some negative impacts on residents and properties in the vicinity of the proposed drying site. These are discussed as separate topics under the following issues: odor (Issues II-3), seepage (II-2), blowing (Issue II-5), effects on property values (Issue II-9), and other potential sites (Issue IV-1).

Letter #25

STATE OF COLORADO

RICHARD D. LAMM
Governor

JOHN W. ROLD
Director

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING – 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 892–2611

SEPT 1976

September 3, 1976

Mr. Philip Schmuck, Director
State Clearinghouse
Colorado Division of Planning
520, 1313 Sherman Street
Denver, CO 80203

RE: DRAFT EIS, DENVER METRO SLUDGE MANAGEMENT PLAN

Dear Mr. Schmuck:

This office has reviewed the above draft EIS report, especially those sections pertaining to possible pollution or contamination of ground-water supplies. As pointed out in the report, this proposed action could have serious adverse impact on the ground-water supplies in the vicinity of the site if adequate surveillance is not maintained.

① This office is in complete agreement with the requirements set forth by the Environmental Protection Agency, that an experimental operation be first established to determine what, if any, adverse ground-water quality problems might develop and for the monitoring of the ground-water under the drying and storage sites. The final design of the drying and storage sites should be based on results obtained from the experimental site. We would also add that before the drying and storage site is designed, a thorough and complete evaluation of the ground-water conditions in the area be made. This evaluation should include, among other things, the depth to water, direction and rate of ground-water flow, and chemical make-up of the waters. Provisions for monitoring wells must be a part of the final design of the storage sites. These wells should be located completely around the site, and especially in a down-gradient direction. In order that escaping effluent might be detected at the earliest, the wells should be located in very close proximity to the drying beds or any other source of pollution. Provisions should be made for ~~the should be made~~ for the sampling of these observation wells on a long-term basis. The results of this sampling should be reported to the Colorado Department of Health on a regular, predetermined basis.

② One other area that should be addressed in the final report is a contingency plan for any break that might develop in the pipeline. We do not feel that this problem was adequately discussed in the draft EIS.

Sincerely,

Richard H. Pearl, Chief
Ground-water Investigations Section

RHP/jp

GEOLOGY
STORY OF THE PAST . . . KEY TO THE FUTURE

EPA Response

① The discussions under Issues II-1 and II-2 define the groundwater situation in and around site B-2. A discussion of the results from the greeley test plots is also contained here. Based on these studies, EPA has developed recommendations for lining of the basins to protect the groundwater (Issue II-2). The USGS will be performing monitoring with the ongoing project; a description of this task is set out in Appendix B. EPA will recommend that these tests be submitted to the State Department of Health.

② The contingency plan for a pipeline rupture is discussed under Issue I-5.

Letter #26

RICHARD D. LAMM
Governor

C.J. KUIPER
State Engineer

DIVISION OF WATER RESOURCES
Department of Natural Resources
1313 Sherman Street - Room 802
Denver, Colorado 80203
Administration (303) 892-3581
Ground Water (303) 892-3587

September 8, 1976

SEP 8 1976
DIVISION OF PLANNING

MEMORANDUM

TO: PHILIP H. SCHMUCK, DIRECTOR, STATE CLEARINGHOUSE

FROM: DR. JERIS A. DANIELSON, DEPUTY STATE ENGINEER

SUBJECT: DENVER METRO SLUDGE MANAGEMENT PLAN
DRAFT ENVIRONMENTAL IMPACT STATEMENT

In accordance with your request, this office has reviewed the above referenced Draft Environmental Impact Statement; and while the statement is well written, it does lack specificity with respect to reduction of historic return flows and ground water pollution.

① With respect to the reduction of historic return flows, the EPA does recognize that there will be an impact; however, it is not quantified nor is it properly mitigated. The amount of water to be diverted from the South Platte River that normally would be available to downstream appropriators could exceed 3 cfs. The statement on page 112 indicates that the Denver Water Board has the right to reuse water imported from the western slope and would presumably allow the Metro District to utilize these transbasin return flows to transport the sludge to the disposal site; however, there is no indication that the Denver Water Board has formally agreed to this proposal. A written commitment from the Denver Water Board must be included in Appendix F to confirm the statement on page 112.

② The ground water pollution problem has not apparently been reviewed as thoroughly as it should have been. There are several unanswered questions which should be addressed primarily dealing with the movement of the water from the sludge drying beds into aquifers below the disposal sites. The possibility of contaminating both the alluvial aquifer as well as bedrock aquifers below the site must be evaluated in more detail. Without these evaluations, the potential detrimental impacts cannot be determined or mitigated.

Jeris A. Danielson
Jeris A. Danielson

JAD/HDS:mvf
cc: Ms. Micki Barnes

EPA Response

① A better description of the impact of increased use of water for Metro's proposed system is found under Issue I-3. At present, the Denver Water Board has not formally agreed to this use; however, neither have they indicated any potential problem with this use (see letter dated October 19, 1976 from Denver Water Board to EPA, letter #7).

② See discussions under Issues II-1 and II-2 on groundwater.

Letter #27

EPA Response

THE STATE HISTORICAL SOCIETY OF COLORADO
State Archaeologist (Interim address) Pioneer Hall,
University of Denver, Denver 80210

September 7, 1976

RECEIVED
SEP 9 1976
DIVISION OF
PLANNING

Mr. Philip H. Schmuck
Colorado Division of Planning
520 State Centennial Building
1313 Sherman Street
Denver, Colorado 80203

RE: Denver Metro Sludge Management Plan (#76-132)

Dear Mr. Schmuck:

The Office of the State Archaeologist of Colorado has received and reviewed the archaeological/cultural resources management statements of the Draft Environmental Impact Statement by the U.S. Environmental Protection Agency for the Metro Denver Sludge Management Plan. (The Office of Historic Preservation of the State Historical Society will comment separately for the State Historic Preservation Officer regarding historical resources.)

Archaeological resources have been, in general, adequately considered. In spite of the negative surface evidence, there remains a possibility of encountering sub-surface resources. Therefore, excavations should be monitored by someone with archaeological training.

With this proviso, the project may proceed according to our review.

For the State Historic
Preservation Officer

Bruce E. Rippeteau, Ph.D.
State Archaeologist Colorado
Phone: 744-1713

BER:ng
cc: Office of Historic
Preservation

This recommendation will be included in the grant conditions for this project. Based on discussions with Dr. Rippeteau, Metro may be given the option to train workers and/or supervisors on the construction project to recognize archaeological artifacts.

Additionally, EPA has worked with the State Archaeologist in resolving the questions raised by the US Department of Interior letter (Letter #31) on pipeline routing and potential archaeological discoveries.

Letter #28

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
REGIONAL OFFICE
EXECUTIVE TOWER - 1405 CURTIS STREET
DENVER, COLORADO 80202

September 14, 1976

REGION VIII

IN REPLY REFER TO:
8OE

Mr. John A. Green
Regional Administrator
Environmental Protection Agency
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Green:

This is in response to the Draft Environmental Impact Statement (EIS) on the Denver Metropolitan Sewage District's Sludge Management Plan. You probably know that the Department of Housing and Urban Development (HUD) has two principal environmental concerns. These are (1) the effect of a proposed action on the urban environment and (2) the consistency of such action with the comprehensive planning for the area, which involves use of the A-95 process. It appears that the A-95 process is being utilized, and that the proposed project will have no significant adverse impact relating to HUD's concern with the urban environment.

Sincerely,

Robert J. Matuschek
Robert J. Matuschek
Assistant Regional Administrator
Community Planning and Development

EPA Response

No comment.

Letter #29

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
11177 West 8th Avenue
P.O. Box 25127
Lakewood, Colorado 80225

8420

September 16, 1976

John A. Green
Regional Administrator
Environmental Protection Agency
1860 Lincoln, Suite 900
Denver, Colorado 80203

Dear Mr. Green:

Thank you for the opportunity to review the Draft Environmental Statement for the Denver Metropolitan Sewage Disposal District's Sludge Management Plan. We have no comments.

Sincerely,

S. H. HANKS
Deputy Regional Forester, Resources

EPA Response

No comment.

Letter #30

Dasel E. Hallmark, PE & LS
3480 South Ivy Way
Denver, Colorado 80222

September 17, 1976

Regional Administrator
U.S. Environmental Protection Agency
Rocky Mountain - Prairie Region VIII
1860 Lincoln Street, Suite 900
Denver, Colorado 80203

Re: Metro Denver Sludge Management Plan
Draft EIS May 1976

Gentlemen:

I have not made a complete review of this document which has brought together valuable technical information but would like to make one brief comment.

① In looking at Table 14, page 79, I was surprised to find that about 8 lbs of sludge is projected as generated per capita per day. Isn't this rate very high? In line with this I would assume industry is loading the plants at a high rate but not necessarily paying their share of costs. As stated on page 10, the 25% share would be borne proportionately by individuals, industry, and businesses.

② Somewhere in the EPA Federal Registers I remember reading that industry must pay their total costs. If this is still true then why infer differently in this report. At 8 lbs sludge per capita per day projected, it is no wonder Metro is in the "sludge mess".

Sincerely yours,

Dasel E. Hallmark

Dasel E. Hallmark, PE & LS

EPA Response

① The amount of sludge generated per person per day according to Table 14 is not 8 lbs per capita/day. In 1985, for example, the figure would lie between .13 and .15 lb/capita/day, depending on whether the DRCOG or Metro population forecast is used (97 mt/day x 2204 lb/mt ÷ population). This would be considered a normal sludge generation figure. Note that this is the quantity of dry solids remaining after anaerobic digestion.

② Public Law 92-500 and the older water pollution control laws require that industries discharging to a municipal facility pay their fair share of capital and operating costs. In general, they would pay an amount proportional to their waste strength. EPA's recent policy in accordance with the Act has been to stress industrial pretreatment, where there is any chance of creating problems in the wastewater plant. In the long term, EPA expects to have industries provide more pretreatment in order to reduce the heavy metal content in sludge. Metro District is initiating an industrial survey to identify heavy metal sour-es (see Issue I-1). The preponderance of sludge generated at the plant, however, is still from domestic sources.

Letter #31

United States Department of the Interior
OFFICE OF THE SECRETARY
MISSOURI BASIN REGION
BUILDING 67, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

IN REPLY REFER TO:
ER-76/746

SEP 20 1976

Mr. John A. Green
Regional Administrator
Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Green:

This is in response to your request for the Department of the Interior to review and comment on the draft environmental statement and draft summary for the Denver Metropolitan Sewage Disposal District's Sludge Management Plan, Adams County, Colorado. We have the following comments to include in your final environmental statement.

General Comments

① 1. The Metro Denver Sludge Management Plan appears to be an excellent solution to the sewage disposal problem. However, inasmuch as the success of the proposal will be dependent on the ability to develop a market for the sludge, it would seem that further investigation and study of this phase of the proposal is a prerequisite to initiation of the proposed construction.

Because the Bureau of Mines' concern in any project is possible mineral involvement, it has no objection to the proposal as outlined in the draft environmental statement.

2. Under provisions of the proposed action as presented in the draft environmental impact statement, impacts on wildlife and related habitats are adequately discussed.

② 3. The final environmental statement should demonstrate implementation of actions that are necessary so the proposed project will not have any adverse effect on historic sites or structures. These actions include:

a. The most current listing of the National Register of Historic Places and all monthly supplements should be consulted.

b. The State Historic Preservation Officer for the State of Colorado should be consulted to determine whether the proposal will affect any cultural site he is nominating to the National Register.

Continued next page

EPA Response

① The system proposed does not depend on a ready market for sludge to be at least minimally successful. Even if the sludge were dried and then landfilled, the cost of the system would be less than the present operation. Considerable energy savings would still occur. Metro will also not need an immediate market, since the site can hold the dried sludge for a number of years. In the long run, however, EPA does think that the potential benefit of this system will not be achieved (i.e., recycling of nutrients and soil amendment), until agricultural or other markets are developed for the sludge. See discussions on marketability (Issue V-4) and emergency disposal (Issue II-15).

② EPA has consulted the National Register of Historic Places and has determined that no structures will be affected by this project. The State Historic Preservation Officer for Colorado has also been consulted on this project (see Letter # 27).

Letter #31,
continued

Mr. John A. Green, EPA, Denver, Colorado

c. Pursuant to Executive Order 11593, Sections 1(3), 2(a), and 2(b), there is a need for a surface survey of the entire pipeline route by a professional archeologist and a professional architectural historian. We note that a records search was made and that much if not all of the pipeline follows a roadway right-of-way; however, in the absence of a documented statement by the State Archeologist or other competent authority confirming that in his judgment the likelihood of any cultural resources being present is minimal, it is agency responsibility to survey all terrain that will be disturbed by construction activity.

③ d. The results of the surveys should be fully detailed in the final environmental statement along with the specific comments and recommendations of the principal investigators.

e. We need to know whether the pipeline right-of-way will penetrate undisturbed terrain or whether it largely follows the roadway right-of-way.

f. Specific guidelines for immediate work stoppage, notification of the State Historic Preservation Officer, evaluation by a professional archeologist, and excavation, if warranted, should be stated in the final environmental statement to be agency policy if unknown cultural resource sites are located during construction.

④ The actions suggested are consistent with Section 106 of the National Historic Preservation Act of 1966 and the Advisory Council on Historic Preservation "Procedures for the Protection of Historic and Cultural Properties" (36 CFR, Part 800). If it is determined that any of the proposed developments will adversely affect cultural resource sites that meet National Register criteria, then the undertaking agency has the responsibility to provide to the maximum extent possible for mitigation of all such adverse effects noted. The undertaking for mitigation should be in consultation with the State Historic Preservation Officer and the Advisory Council.

Specific Comments

⑤ 1. On Table B, page 16 of the "Summary," water quantity is stated as an environmental parameter at the proposed sludge drying, storage, and distribution site. The stated impact is its removal from the South Platte River. The importance is said to be minor, and the severity of impact is said to be moderate. Mitigation is said to be feasible in part. The stated mitigation methods are said to be: (1) to avoid irrigation and (2) to return the water. Perhaps the information as provided in this table should be expanded and clarified in the text of

Continued next page

EPA Response

③ EPA has consulted with the State Archaeologist on this point. We sent the Archaeologist detailed maps of the pipeline right-of-way. It was agreed that because the pipeline exclusively follows public rights-of-way that have been considerably disturbed (Burlington Ditch embankment, roadways, Sand Creek sewer line), a surface archaeological investigation would probably prove inconsequential. EPA will require the Metro District in a grant condition to either hire an archaeologist to monitor construction of the pipeline, or else provide training to supervisors and/or workers on the construction project to recognize archaeological artifacts and situations. Metro District would still be responsible for notifying the State and EPA in the event of a find. A proposed statement of this grant condition is found in Appendix A of this volume. Also a better description of the pipeline routing is found in Issues I-2 and I-4, along with potential impacts.

④ This wording will be incorporated into the grant conditions in Appendix A.

⑤ the final environmental statement. No mention could be found in the
text of the EIS of the actual quantity of water needed, nor of the
expected return flows to the South Platte River. It is suggested the
mitigation methods of avoiding irrigation and/or returning the water
be fully discussed in terms of their possible implementation. ⑥ What are
the impacts of avoiding irrigation or returning the water? What are
the implications of either mitigation method on the water quality of
the South Platte River and the future Narrows Reservoir to be located
7 miles west of Fort Morgan, Colorado. The Narrows Dam will start
intercepting South Platte water for storage in 1983.

⑦ 2. Page 13 shows a list of alternatives which includes "no action." The final environmental statement should elaborate on the ramifications of the "no action" alternative. What are the implications of this alternative regarding the population growth, refusing more sewer hookups, controlling population growth (constitutional implications), energy generation and conveyance requirements and water development and conveyance requirements?

⑧ 3. On pages 46-55, the general configuration of the Denver basin should be described in the summary of geology and geohydrology, because it is directly significant in controlling the ultimate direction of movement of ground water in the confined and semi-confined aquifers below the unconsolidated surficial materials.

⑨ 4. Figure 6 on page 47 suggests that the distribution center may be east of section 22 and possibly in section 23 of Township 2 South, Range 65 West; figure 12, on the other hand indicates a location in sections 12, 21 and in the western halves of sections 15 and 22. Because the hydrologic properties of the materials underlying these respective locations may differ considerably, the location should be consistently and correctly shown.

⑩ 5. On pages 54 and E-31 the environmental statement declares that between the valley fill aquifers and the Laramie-Fox Hills aquifers lies a thick series of rocks of low permeability. This appears to ignore the sand, sandstone, and conglomerate aquifers of the Denver, Arapahoe and Dawson Formations; in the immediate vicinity of the project these aquifers have been tapped principally for domestic supplies, but only a short distance downgradient to the west and southwest they have afforded supplementary public supplies.

⑪ 6. The potential for overflow of the drainage impoundments at the proposed center (p. 96, par. 3; p. 94, fig. 12; and p. 111, par. 4) should be mentioned, even though it does not appear that it would result in

Continued next page

EPA Response

⑤ A better description of the amounts and impacts of the additional water use thru this system is found in the discussion under Issue I-3. The mitigation measures suggested in the draft EIS were in part developed because the resolution of the issue at that time was an open question. EPA felt that the likely impact on existing water rights would be considered "minor". However, it did not know the extent of the concern about this issue, and had to be prepared to discuss alternatives to increased consumption if necessary. Our reading of the situation at present is that the key actor in this issue, the Denver Water Board, is not overly concerned about the impact. Until EPA is informed otherwise, that the amounts of water to be used in this proposed project are not acceptable, we do accept the Metro proposal as originally envisioned. This would include the use of purge water on the site as irrigation water.

⑥ Since the amount of water involved in the proposed project would be about 4160 m^3/day [1.1 mgd] versus about 490 m^3/day [.13 mgd] now consumed in the Lowry Bombing Range operation, EPA still maintains that the overall effect on Platte River quantity is small. By contrast, the Burlington Ditch, which runs by the Metro plant, can withdraw up to 1.47×10^6 m^3/day [388 mgd] from the River. Therefore changes to water quality by depletion are insignificant whether the present system, the proposed system, or a modified proposed system without irrigation is used. In terms of the return flow and its effect on water quality, EPA would expect that all necessary permit limitations would still be met; some additional treatment costs would be experienced at the Metro plant. There should be a negligible effect on the waters that eventually reach the area where the Narrows Project is proposed.

⑦ The "no action" alternative in this case has a realistic meaning. Metro District already has an existing sludge operation, although it is close to capacity in some unit process areas. Were EPA to choose the "no action" alternative, this would first of all mean a continuation of the operations at the Lowry Bombing Range. This alternative is thoroughly discussed in the EIS and further in Issue III-1. Choice of this alternative still allows a further choice of funding additional units to the existing system or no federal funding. EPA could well fund additional capacity to the existing system; environmental impacts directly attributable to the system would be identical to those described under continued Lowry operation. EPA could also choose to not fund this project at all, given other priorities. This need not be assumed to be an antigrowth effect. Metro District members could raise funds for construction of the project as well. Since the choice here is not a system versus no system, but rather a "better" system against an existing system, EPA thinks that the approach taken in the EIS in developing and evaluating alternatives is a reasonable one. A discussion of project alternatives is found under Issue IV-3.

⑧ The configuration of the Denver basin is presented in the improved description of the B-2 site. The Lost Creek Groundwater District (see Letter # 44) has raised issues dealing with possible contamination of various aquifers beneath the site.

⑨ Figure 6 on page 47 of Volume I shows an arrow pointing toward the Distribution Center. The site is off the map to the east. Figure 12 shows the correct location of the site. Incidentally, the site is located in Range 64W, Township 2S, and includes all of sections 16 and 21, and the western halves of sections 15 and 22.

⑩ The groundwater formations under site B-2 are discussed in Issues II-1 and II-2. The discussions there recognize that domestic wells do draw water from the Denver-Dawson-Arkose formations, although in small quantities. EPA is concerned that this formation be protected from leachate from the sludge drying operation.

Letter #31, continued

⑪ significant problems. Presumably an extreme storm event causing overflow would provide ample dilution, and the long reaches of ephemeral channels would provide ample dispersion prior to entry into biologically active waters.

⑫ 7. On the first page of the EIS, in Section 3, "Environmental Impacts," it states that "an increased amount of water over that now consumed in the existing sludge disposal practices of metro will be carried in sludge, purge water and additional irrigation water to the Adams County site, reducing flows in the South Platte River downstream of the central plant." It is suggested that estimated figures of the amount of water needed for the sludge, the purge water, and the subsequent irrigation be given.

⑬ 8. On pages 111-112, the first sentence under the hearing "Water Rights" needs clarification. It says, "In the process of transporting liquid sludge to the drying and distribution center, and during the periods of purging the pipelines with secondary effluent and any additional irrigation water beyond what is now consumed in the sludge disposal process will be carried from the central plant to the Adams County site." What will be carried from the central plant to the Adams County site? How much? When? What are the environmental implications?

⑭ 9. Page 213, it is not clear what the environmental team is, nor what the members of the team did with regard to this report. Perhaps the environmental team could be listed as Section X of the EIS and a statement made whether these persons are CH2M-Hill employees, Engineering-Science employees, EPA personnel, etc.

⑮ 10. On page E-14 impacts on ground water from the use of mine spoil sites in sludge disposal are reportedly considered to be insignificant, because ground water is not plentiful in the consolidated rocks involved. However, the statement should also address the ground water/surface water relationships involved and the related fate of leachates. Movement of leachates through the fractures in consolidated rocks of the types mentioned should be relatively rapid, and there should be very little opportunity for amelioration of quality from chemical changes, ion exchange, adsorption, or absorption. Impacts of the resultant rapid transmittal of pollutants through fractured aquifers to streams should be evaluated.

We appreciate the opportunity to comment on your environmental statement.

Sincerely,

John E Rayburn
for Special Assistant
to the Secretary

EPA Response

⑪ This issue is discussed under Issue II-6.

⑫ See Issue I-3.

⑬ The typographical error in this sentence has been corrected. See discussion under Issue I-3.

⑭ The persons listed on the "Environmental Team" prepared portions of this EIS. The list has been updated and clarified.

⑮ These statements are all true. However, the runoff from these mine spoil sites is quite degraded before sludge application, being highly acidic. The use of sludge on sites such as these will initially raise the pH of the runoff, while adding other pollutants from the sludge. The net effect on runoff quality may in some cases actually be positive, and in most cases will not significantly degrade further the runoff quality. In the long-term, the application of sludge will reduce the quantity and improve the quality of runoff by improving the moisture-holding capacity of the soil and enhancing revegetation of the site. Each mine spoil site should be evaluated before sludge application for potential effects based on site-specific conditions.

Letter #32

DR. F. ROBERT McGREGOR
2078 SOUTH WINONA COURT
DENVER, COLORADO 80219

17939

22 September 1976

Mr. John A. Green
Environmental Protection Agency
1860 Lincoln Street - Suite 900
Denver, Colorado 80203

Re: Denver Metro Sludge
Environmental Impact Statement

Dear Sir:

The sludge recycling effort of the Metropolitan Denver Sewage Disposal District is an encouraging forward step. This step, however, is too small for this age of energy shortage and conservation momentum.

A great deal of study has been completed on the international level concerning the recycling of resources including municipal wastewater sludge. As a result of these efforts, a greal deal of interest has been focused on sludge recycling. Major capital expenditures are about to be made on sewage treatment systems in this area and we cannot afford to make mistakes. We need to take full advantage of the experience of others in this regard. The proposed plan does not take full advantage of the knowledge previously developed in this field.

Economic considerations should be a foremost long-term objective in recycling. A sludge recycling system must be optimized to be of economic value. The values take on many forms including fertilizer, saved treatment costs, increased agricultural production, clean water and clean air.

The approach taken by Denver Metro should be more optimized. The wet sludge should be injected directly into the agricultural fields rather than being first dried in large sludge drying beds which may cover as much as a square mile. Further, the sludge should be utilized on agricultural fields in the South Platte Valley where the benefits per ton can be maximized. The sludge is a marketable material and it is not necessary to own the lands that it is used upon if this approach is taken.

Continued next page

EPA Response

Although EPA agrees in concept with your statement that such a system should be optimized, we think that we are a long way from knowing how to accomplish this. There is a lack of information about existing sludge recycle systems in this semi-arid area, simply because they are so few in number.

For example, you suggest that wet sludge should be applied instead of dried sludge. We agree that this would recycle greater amounts of nitrogen to agriculture. However, some form of storage would be needed during winter months. A different selection of crops (more restrictive) would be required for the wet sludge, because of the greater potential for pathogen transmission. Metro has chosen the dried sludge approach because it offers the potential for greater flexibility of use. We also must point out that optimizing for potential uses assumes that there are willing users. This is not completely the case at present; Metro's system must go through a trial-and-error process to discover what the best potential use(s) are.

Letter #32, continued

Mr. John A. Green -2- 22 September 1976

Further public education is needed relative to recycling of wastes. Sometimes local political problems are difficult to overcome. Nevertheless, the American people are about ready to accept the waste recycling concept. Not nearly enough has been done by Denver Metro on public information dissemination. Often times the data that has been distributed has been in a defensive posture. An aggressive and forward looking farmer or rancher truely interested in agriculture would quickly recognize the added value of having sludge applied to his land. The approach of buying the farm lands is too expensive and not necessary. The sludge is a marketable material of significant value. We don't believe that these individuals have been identified. It is time that some of the money spent on studies is spent on positive data dissemination and planning which would lead to a strong and viable sludge recycling program which would aid the environment, add to our food and fiber production capability, improve the economy of the Denver metro area, and more fully utilize these valuable fertilizers which are normally thrown away.

Very truly yours,

Dr. F. Robert McGregor

EPA Response

You are absolutely correct that further public education concerning the recycling of waste is needed. EPA has begun to strongly encourage the recycling of wastewater, solid materials such as aluminum cans, bottles, combustible materials, and of course, sludge. There is a formidable problem of public acceptance, however, that must not be overlooked. This EIS indicates a segment of the public that is looking to this system for eventual use of sludge on home gardens (see Volume I, Appendix F). However, there is an equally vocal portion of the population who do not consider the use of sludge as a benefit. In particular, the numerous farmers in the vicinity of the proposed site B-2 who objected to the project feel that the dried sludge will have little or no benefit to them. EPA does agree that sludge will have only limited value to dryland farming operations, especially because of costs. On the other hand, Metro has indicated that a number of farmers are interested in trying the sludge (e.g. see letter #4). EPA thinks that while nutrient-bearing sludge may eventually be marketable, for the near-term Metro may have to develop the market thru an aggressive promotion and perhaps free distribution of the material. EPA will also continue to promote the beneficial use of sludge, while trying to eliminate some of the constraints to its use.

Letter #33

CITY AND COUNTY OF DENVER

W. H. McNICHOLS, JR.
Mayor

DEPARTMENT OF PUBLIC WORKS

OFFICE OF THE MANAGER
CITY AND COUNTY
BUILDING
DENVER, COLORADO 80202

September 23, 1976

RECEIVED
1976
OFFICE OF [illegible]

Mr. James Sanderson
Regional Counsel
U. S. Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Sanderson:

Re: Draft Environmental Impact Statement for Metropolitan Denver Sewage Disposal District No. 1, "Sludge Management Plan"

"The draft Environmental Impact Statement as prepared by the U. S. Environmental Protection Agency relating to the Sludge Management Plan of the Metropolitan Denver Sewage Disposal District No. 1 has been reviewed and evaluated. The City and County of Denver supports the concept of land disposal of sludge generated by the Metro and Denver Northside Treatment Plants. Specific comments relative to the draft Impact Study will be forwarded at a later date."

The above statement was presented orally at the Public Hearing held on September 8, 1976 in Room 269 of the U. S. Post Office at Denver, Colorado, and the following comprises our written comments on the proposal.

① The City and County of Denver has, for several decades, been involved in the land disposal of sludge, and it had only been during the "Sludge Incineration Process Years" of operation at the Metro District facility that Denver sludge was unavailable for use by the Denver Parks Department. Historically, the Denver Parks Department has been the major recipient of "air dried" digested sludge resulting from the anaerobic digestion process within the operation of the City's primary sewage treatment plant, normally referred to as the Denver Northside Plant. Since the Metro sludge incineration process was abandoned several years ago in favor of land disposal of sludge at the Lowry Bombing Range, the Denver Parks Department has again been utilizing Denver digested sludge in limited amounts. There is, has, and will continue to be a market within the City and County of Denver Parks Department for this anaerobically digested sludge.

② The Denver Northside Treatment Plant was originally constructed to provide the capability of air drying digested sludge resulting from its anaerobic sludge digesters. The use of these sludge drying beds was minimized at the request of the State of Colorado Department of Health during the formative years of the Metro Denver Sewage Disposal District (of which Denver is the principal financial contributor) in order to protect the local groundwater from probable contamination

Continued next page

EPA Response

① **EPA recognizes that the City and County of Denver's Parks Department has been an old and substantial user of Metro District sludge in a beneficial way. EPA can only deplore the chain of events that has made it difficult for the City to be a continual user of this sludge. EPA will continue to press the Metro District to minimize the financial burden that would accrue if the District were to charge the City for use of this sludge. Other municipalities inside and outside of the District are interested in using this sludge material for parks improvement (see Volume I, Appendix F).**

Letter #33
continued

from percolation of decant water through the unlined drying beds. With the consideration of abandonment of the drying beds in mind, appropriate contract negotiations proceeded, once the District was formed, and the requirements of the current "Service Agreement" were finalized. Under terms of that agreement, Denver enjoys the option to transfer its sludge to the District facility for disposal or not.

Therefore, the City, through its Wastewater Management Division, has been investigating the possibility of reactivating its sludge drying beds for independent control of its sludge resource. (There is no apparent logic in Denver discharging its sludge to the Metro District, paying the District for its disposal and then buying it back for use as a compost or limited fertilizer by the Denver Parks Department.) This particular cost aspect of the Metro proposal is currently under detailed analysis by Wastewater Management personnel.

② The City has approached the State Water Quality Control Division and Environmental Protection Agency in order to consider a viable alternative to the current Metro plan. As a result, the City anticipates presenting its proposal to the State Water Quality Control Commission at the October Commission meeting. Briefly, the proposal consists of reactivating the existing Denver Northside sludge drying beds as follows:

1. Waterproofing all beds with an impervious material so that subsurface filtration will be precluded;
2. Installing a sand or filter bed on top of the impervious material and an underdrain which will assure flow by gravity;
3. Construction of recovery tanks for the underdrains to collect the runoff and return it to the plant headworks;
4. Construction of the beds in order to take full advantage of evaporation.

Some of the benefits to be derived from this method of handling Denver's digested sludge would be as follows:

1. The Denver cost of pumping digested sludge to Metro at a 5 per cent solids concentration will be precluded;
2. The cost and use of chemicals (polymers) added to assist in Denver sludge de-watering by Metro will be eliminated;
3. The total cost of de-watering the Denver sludge at Metro (vacuum filtration) will be eliminated;

Continued next page

EPA Response

② Issue IV-4 discusses the Denver Northside proposal for separate sludge treatment and disposal of Northside digested sludge. It is EPA's position that Northside sludges are already factored into the design of the Metro District's offsite solids program proposed in this EIS. EPA therefore will not fund facility planning, design or construction of separate sludge drying/disposal facilities at the Denver Northside Plant.

Your discussion also did not recognize the potential benefits that could accrue to the Denver Northside and Metro liquid phase operations if the Northside decant were to be included in the pipeline flows to the drying site. A substantial decrease in BOD, suspended solids and nitrogen loading to the Metro waste activated secondary system could occur that would have financial benefits to Northside as well.

Mr. James Sanderson
Page 3
September 23, 1976

②

4. The cost of transporting the Denver sludge, plus residual chemicals, to a disposal site will be eliminated;

5. The life of the disposal site, insofar as sludge disposal is concerned, will be increased by ± 15 per cent;

6. Sludge recycling can be accomplished much sooner by utilization of the Denver drying beds;

7. There is an immediate market for the dried sludge within the Denver Parks Department;

8. There is a strong possibility of handling additional digested sludge from the Metro District at some time in the near future;

9. Possible advantages accruing to the Metro District in view of this proposal and the fact that Metro will, in the near future, have its own anaerobic digester capability are:

    a. A viable alternative by reducing the land requirements for the Metro sludge farm;

    b. Cost savings of a potentially considerable magnitude concerning pipelines, pump stations, land acquisition, land development, litigation costs, replacement water costs;

Preliminary savings in excess of $300,000 can be realized by the City and County of Denver in handling its own sludge disposal. Overall savings to the agencies involved in the Metro District could be considerably more.

Other concerns which the City wishes to identify with regard to the draft Environmental Impact Statement are as follows:

③

1. The apparent continuing misconception relating to what the Metro District is and who they serve. On page 3 of the summary report, the District should be identified as a special service district with 21 current members operating a single treatment plant located in Commerce City. Several members of the District operate their own facilities and contract to provide services to still other smaller local government entities. (The City, as but a single member of the District, provides service to 45 other local governments, as well as its own population tributary to Denver Northside) The perpetuation of a concept that the District represents the City and County of Denver or any other district member must be clarified and the subliminal theme of the draft report which dramatizes this misleading concept must be corrected;

Continued next page

EPA Response

③ EPA does recognize this arrangement of municipalities and districts within the MDSDD #1. It is a fact, however, that approximately one-half of the Metro District Board is comprised of City and County of Denver members. It is also the case that the Metro District Central Plant provides secondary wastewater treatment to most of the metropolitan area, including the City and County of Denver.

Letter #33, continued

Mr. James Sanderson
Page 4
September 23, 1976

④ 2. In describing Metro's current sludge operation on page 6 of the summary report, it is implied that Denver sludge as well as the Metro sludge is responsible for a number of outstanding problems with regard to disposal at the Lowry Bombing Range. It must be noted that disposal of Denver's sludge as a discreet material is not subjected to the same requirements as the Metro product. The Metro District staff has chosen to utilize Denver sludge as a conditioning agent for their sludge disposal process, thereby reducing the overall cost requirements for de-watering and polymer addition in their normal operating procedures. Further, utilization of the Lowry Bombing Range area for disposal is provided by the City and County of Denver to the Metro District on a no-fee basis;

⑤ 3. The complex water rights issue appears to require immediate attention. On page 112 of the complete report, the validity of the assumption by the Environmental Protection Agency that the Denver Water Board will allow Metro to continue to use its water for the sludge transportation system needs verification before that transportation plan can be accepted. That assumption alone could heavily impact the choice of final sites for the "sludge farm," and therefore, the feasibility of continued use of Lowry Bombing Range land should be reemphasized.

The City considers the reactivation of the Denver sludge drying beds to be a most important alternative in the final design of the Metro proposed "sludge farm" disposal plan, as well as the feasibility of continued use of Lowry Bombing Range land. The staff of the Wastewater Management Division is available to meet and discuss these proposals at your convenience.

Very truly yours,

Harold V. Cook
Harold V. Cook
Manager of Public Works

HVC:clj

EPA Response

④ The positive value of Denver's digested sludge is recognized. Calculations of the cost benefit of using Denver digested sludge as a conditioning agent are shown in the discussion under Issue IV-4. The City must recognize, however, that the secondary waste activated sludge generated at the Metro plant is also in part Denver's sludge. This also contributes to the present high cost of sludge processing at the Metro District plant which has spurred the search for a better, less costly way of disposal. EPA can sympathize with the City and County that perhaps the original contract between the City and the District is not reflective of current financial trends and may need to be revised.

⑤ See discussion on water rights in Issue I-3. This issue is not expected to affect the development of the Metro project.

Letter #34

11227 Woodson Ave.
Kensington, Maryland 20795
September 27, 1976

Mr. John A. Green
Regional Administrator
U.S. Environmental Protection Agency
Rocky Mountain - Prairie Region VIII
Suite 900
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Green:

As a joint owner of a considerable portion of the land within the proposed site for drying and storage of sludge from Metropolitan Denver, I would like to comment on the draft Environmental Impact Statement (EIS) regarding the Management Plan for Wastewater Sludge.

① A major shortcoming of the above EIS is that it fails to adequately address the issue of the irreversible destruction of quality farmland. Although the EIS briefly mentions the destruction of the soil profile at the proposed site (B-2), no attention is given to the quality of farmland at this site, nor are there comparisons of agricultural quality of land at alternative sites.

② The attached, recent memorandum from the Chairman of the President's Council on Environmental Quality, August 30, 1976, instructs federal agencies to determine the existence of prime farmlands in the areas of impact analyzed in Environmental Impact Statements. Has information as the relative agricultural quality of land at the proposed site been obtained from the State Soil Conservationist for the purposes of the EIS? I presume that the requirement in force since August 30, 1976, applies to the Denver Sludge EIS since it is still in the process of completion.

I believe that it is unconscionable, from both an environmental and civil rights point of view, that the proposed Denver sludge disposal might condemn private farmland rather than use potentially available public land such as the Lowry Bombing Range. Has EPA required the full investigation of whether permission can be obtained for use of the Lowry Bombing Range for the proposed drying/distribution site? It would seem that condemnation of private land would necessitate irrefutable evidence that land already in the public trust is not available.

I will appreciate your reply to this letter, with answers to my questions.

Respectfully yours,

Betty Mundell Bennett

cc. Representative Ted Strickland
Marlin Opperman, Attorney at Law

EPA Response

① The discussion of farmland productivity loss as a result of the Site B-2 operation is found under Issues II-1, and II-8.

② The Soil Conservation Service commented on this EIS, but did not discuss the issue as to whether the lands affected by site B-2 were considered "prime agricultural lands" as defined by the Council on Environmental Quality. EPA has evaluated the potential for conversion of prime agricultural lands in its Denver Overview EIS released in June, 1977. Prime agricultural lands indentified were predominantly irrigated farmland areas, particularly along the South Platte River. It is certainly EPA's intention to minimize the impact of its project on existing farmlands. EPA would prefer to locate this drying/distribution on public lands. However, the discussions under Issue IV-1 demonstrate that such public lands are not immediately available, and possibly never will be in this area.

Letter #35

Attachment to Letter #34

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
722 JACKSON PLACE, N. W.
WASHINGTON, D. C. 20006

August 30, 1976

MEMORANDUM FOR HEADS OF AGENCIES

SUBJECT: Analysis of Impacts on Prime and Unique Farmland in Environmental Impact Statements

This memorandum provides guidance to Federal agencies on how to carry out evaluation of the impact of major agency actions on prime and unique farmland in the course of preparing environmental impact statements (EIS). *

Paragraph 101(b)(4) of National Environmental Policy Act (NEPA) establishes a Federal policy to preserve important historic, cultural and natural aspects of our national heritage and maintain, wherever possible, an environment which supports diversity and variety of individual choice. This policy should be understood to include highly productive farmlands.

Efforts should be made to assure that such farmlands are not irreversibly converted to other uses unless other national interests override the importance of preservation or otherwise outweigh the environmental benefits derived from their protection. These benefits

stem from the capacity of such farmland to produce relatively more food with less erosion and with lower demands for fertilizer, energy, and other resources. In addition, the preservation of farmland in general provides the benefits of open space, protection of scenery, wildlife habitat and, in some cases, recreation opportunities and controls on urban sprawl.

As part of its policy to preserve the Nation's prime farm, range, and forest lands, the Department of Agriculture (USDA) has recently announced a general policy to establish and keep current an inventory of prime and unique farmland. Recent estimates conclude that of 1.4 billion acres of privately owned lands in the United States, approximately 275 million are classed as prime farmlands.

Federal agencies should attempt to determine the existence of prime and unique farmlands in the areas of impact analyzed in environmental impact statements prepared in compliance with Section 102(2)(C) of the NEPA. This should include threats to the continued use and viability of these farmlands not only from direct construction activities, but also from urbanization or other changes in land use that might be induced by the Federal action.

Continued next page

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* Prime farmlands are those whose value derives from their general advantage as cropland due to soil and water conditions. Unique farmlands are those whose value derives from their particular advantages for growing specialty crops.

Letter #35, continued

The Department of Agriculture, at its field locations throughout the country, is committed to assisting Federal agencies in the identification of prime or unique farmlands, and in nearly all cases has complete information on land areas which may be impacted. This should simplify and reduce the burden on other agencies in carrying out their impact analysis. Initial contact should be made with the USDA Land Use Committee in the state where the lands under consideration are situated. This Committee can be located by contacting either the Chairman of the USDA Rural Development Committee in the state, or any nearby USDA office. The State Land Use Committee will then help facilitate contacts with the appropriate USDA office and personnel so that all available information on prime and unique farmlands within the project area is accessible to the agency preparing an EIS.

Finally, the Department of Agriculture has agreed to place a major new emphasis on the review and evaluation of draft environmental impact statements with respect to impacts on prime and unique farmland. In undertaking these reviews, USDA will use soil, range, forest, water resource, and other surveys and information which may be applicable. This service of the Department should help improve the quality of all EISs.

Further information on where agencies may obtain assistance in identifying prime and unique farmland and analyzing significant impacts on it from agency activities can be obtained from State Soil Conservation Service (SCS) offices shown on the attachment. Information on new USDA procedures to review impact on prime and unique farmlands in draft EISs can also be obtained from these sources.

Russ Peterson
Russell W. Peterson
Chairman

Attachment

Attachment to Letter #35

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Letter #36

TCDHD
TRI-COUNTY DISTRICT HEALTH DEPARTMENT
4857 SOUTH BROADWAY
ENGLEWOOD, COLORADO 80110
303 761-1340

September 28, 1976

Mr. John A. Green, Regional Administrator
United States Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Green:

This department has reviewed the draft Environmental Impact Statement on:

Management plan for waste water sludge
Metropolitan Denver Sewage Disposal District No. 1
Denver, Colorado
E.P.A. Project Number: C0080341

We would offer the following observations and comments for the record:

①

1. page 93. "The drying basins could process about 33,000 dry metric tons (36,000 short tons) of sludge per year. Sludge applied to the basins in layers of 60 cm (24 in.) can be expected to dry to 40 to 50 percent solids in about twelve months."

   page 30. Indicates that 1974 sludge production was 33,000 tons with a projection to 61,000 tons in early 1980's.

   page 31. "Secondly, the actual time needed for drying in the basins is not precisely known. A year's time is assumed for design purposes, but longer or shorter drying times might be needed." "Metro District has indicated that no more than 180 hectares (450 acres) of the proposed 240 hectares (600 acres) drying storage area need to be developed immediately."

   This department has had conversation with Metro representatives as late as July 20, 1976. On that occasion we were led to believe the proposal was to charge the basins at 2 - 4 inch depth and not 24 inches. At 24 inches there will be crusting which inhibits evaporation and air drying. The majority of dewatering would be by percolation, possibly causing water pollution problems. This recent alternate proposal as to basin loading is not covered in the EIS.

Continued next page

EPA Response

① A discussion of the adequacy of Metro's design capacity for the sludge drying basins is presented under Issue II-12. You should be aware of some inaccuracies in your assumptions under point #1 of your letter: Metro's projected sludge generation for 1985 is expected to total 61,000 tons as stated on page 30 of the EIS. However, only about 36,000 tons would reach the drying site because of anaerobic digestion. Even if the Northside Plant were to add its supernatant to the pipeline flow, the expected yearly amount of flow would only be about 345,000,000 gallons per year, rather than the 716,750,000 gallons calculated under your point 2 (e). It is also very likely that Metro's projections are high, since they assumed a 4-5% per year growth rate; the Metropolitan area growth rate recently has been between 2 and 3%. Finally, Metro indicates in their most recent correspondence that they are again proposing to load the basins with up to 24" of sludge, rather than the 2-4" depth they were claiming at the time your letter was written.

Letter #36, continued

U.S. Environmental Protection Agency
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② The degradation of ground water is also referred to in the EIS at page 29 "Some water will be lost to evaporation and some will stay in the dried sludge, but most will move downward where it will likely result in degradation of water quality to a degree that would make the ground water unacceptable as a source for drinking water."

This statement on environmental impact in and by itself should be enough to render this project proposal unacceptable. We concur with the Colorado Water Quality Control Division that the drying beds should include impervious lining and some type of underdrainage.

③ 2. As was stated on page 31, the drying characteristics of this type of sludge are not known; however, as a rule of thumb average evaporation from a body of water in the area is .1 inch per day or .0625 gal./square foot/day. For design purposes we also feel the facility should provide for a minimum 3 month storage. With this in mind, the proposal is:

(a) 2% solids transferred
(b) 40 lbs. of dry material/wet ton
(c) 1960 lbs. water/wet ton
(d) 235 gal. water/40 lbs. dry sludge
(e) 61,000 dry tons = $\frac{122,000,000}{40}$ X 235 = 716,750,000 gal./yr.
(f) 716,750,000 gal./yr. = 1,963,698 gal./day
(g) At the above evaporation rates with no percolation would require 721 X 1.25 = 901 acres
(h) If dried to 40% solids 901 X .60 = 541 acres.

We do not believe this material has as high an evaporation rate as presented and more ground would have to be set aside for sludge drying.

3. It would appear this proposal is premature and that a final EIS cannot be prepared unless and until the following unknown factors have been resolved:

(a) firm plan of operation established
(b) drying and dewatering characteristics of anaerobic digested waste activated sludge both mesophilic and thermophilic.

④ page 32. "The performance of anaerobic digesters on the raw and waste activated sludges now treated at Metro must be considered an unknown area at present. Anaerobic

Continued next page

EPA Response

② We agree with your position that the environmental impact of considerable quantities of leachate moving toward the groundwater from this site would be unacceptable. See discussion under Issues II-1 and II-2. EPA will require the District to meet certain performance standards on the permeability limit and depth of impermeable lining during construction of the drying basins.

③ Again, because of the difference in amounts of sludge to be applied, EPA believes that there is sufficient capacity for drying for the design period.

④ Because of the nature of the drying operation, EPA now feels that a firm plan of operation may not be possible at this time. The recent research at Greeley performed by Metro does indicate that satisfactory drying can be accomplished in a 90-150 day period. The most satisfactory mode of operation will probably not be established until a certain trial-and-error period has been undergone. EPA prefers to adopt the approach that positive protection to the groundwater through lining of the basins will lessen the need to have a fixed plan of drying ahead of time. Results from the San Jose California drying basins do demonstrate the general effectiveness of the drying approach, however.

Performance of the anaerobic digesters can also be viewed in a similar fashion. The general performance characteristics of anaerobic digesters are, of course, quite well known. Performance of digesters in a thermophilic mode, however, is known in only a few cases, notably the Hyperion, Los Angeles plant. It would be better to assume the known characteristics of digester operation for this project, in assessing project impacts and merits. Metro has indicated a willingness to research thermophilic operation, if research funds are available. Recent pilot studies on mesophilic digestion of a 50-50 blend of primary and waste-activated sludge indicated no operational or performance problems (Reference 1). Digestion proceeded smoothly, and digested sludge concentration was 2.5 to 3.0 percent solid when the feed sludge concentration was about 5 percent solids. No solids-liquid separation took place in the digested sludge mixture.

Letter #36, continued

U. S. Environmental Protection Agency
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④ digestion can improve the dewatering characteristics of sludges (resulting in less chemicals for conditioning). However, digestion of secondary waste activated sludge may not perform in the same fashion. It might be expected that odor and chemical-related problems at the Lowry site will be reduced by the measures already under construction. Conversion of the digestors to the thermophilic mode might further improve sludge dewatering characteristics."

⑤ 4. With all the unknown factors and the objections to the proposal as it now exists, the second alternate as it is presented on page 33 appears to be a solution for the short term until the firm long-range plan is developed and approved.

"A second alternative might be to develop some modified type of drying/windrowing operation to store anaerobically digested-vacuum filtered sludge at Lowry for sale or distribution to local farmers, sod farms, etc. This would involve a substantial change of the use of the bombing range that would need approval by the Federal managers. The alternative suggested here differs from the site alternative consideration for the Metro proposed system in that minimal capital investment for new facilities would be required. Metro could store some sludge and landspread the remainder until a market developed. Such a system would need large amounts of land available in order to remain flexible."

As stated this alternative would require minimal capital investment.

This alternative would eliminate the water pollution problem, the sludge would dry faster thereby reducing odor, would require less land than is proposed by the EIS, and the land spreading until a market was developed would remain the same.

The Tri-County District Health Department wishes to commend Denver Metropolitan Sewage Disposal District No. 1 for its concern and wish to recycle a usable product to the environment. However, we, as the local health department, are charged with seeing to the following responsibilities:

(a) That the processing and production of the end product does not create public health hazards or nuisances.

(b) That the end product meets the standards of quality for a fertilizer within the community.

Continued next page

EPA Response

⑤ EPA's position at this time is that enough information is known about the type of operation proposed to go ahead with the project. Much of the information can be developed when the project becomes operational. It is also EPA's position that should the project be unacceptable to Adams County or others, the Metro District should pursue a form of sludge drying and distribution as has been suggested for the Lowry Bombing Range. Metro's current position is that if the land recyling sludge system is unacceptable, they would pursue incineration as a preferred alternative. This difference of positions would probably be the subject of another EIS.

Letter #36, continued

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(c) That if the end product does not meet said standards, we are assured it is disposed of in a manner that it does not create a health hazard or nuisance.

We recommend this proposal be amended to provide the second alternate stated in #4 above as the short term management plan and the long term management plan be delayed until more is known about the newly completed plant's sludge characteristics.

If there are questions, please contact me.

Sincerely,

Donald L. Turk
Donald L. Turk, Associate Director
Environmental Health Services

DLT:bmm

Letter #37

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION
WASHINGTON D.C. [illegible]

September 29, 1976

Mr. John A. Green
Regional Administrator
United States Environmental Protection Agency
Region VIII
1860 Lincoln Street
Denver, Colorado 80203

Ref: 8W-EE

Dear Mr. Green:

Thank you for your letter and for the copy of the draft Environmental Impact Statement for Metro-Denver's Sludge Management Plan.

After an informal review of this well written document with several other scientists, I have the following personal comments and/or suggestions:

① Like most large cities, Denver produces sludge containing levels of heavy metals which are higher than the "background" due to contamination, presumably by industrial effluents. Fortunately, levels (especially of cadmium) are not as high as those of some other sludges, and land application is feasible, provided suitable safeguards and controls are exercised. However, reduction in the amounts of heavy metals and organics (PCB, etc.) present is highly desirable, and would open up a broader range of use options. Such improvement in sludge quality would obviously result by requiring industry to pretreat their effluents more thoroughly prior to discharge to the municipal sewage systems.

② An area of concern is the unregulated and uncontrolled distribution of sludge, compost or sewage in any form to farmers, home gardeners and other users because of the potential for improper handling and abuse. If sludge/compost is available free or at low cost, there is the potential for use of excessive amounts on a given land area; present levels of chemical contaminants in Denver sludge are high enough under such circumstances to cause food contamination and adverse health effects. This is especially so, if cumulator crops are used or sludge is applied onto growing crops, resulting in physical contamination. The possibility of direct ingestion of sludge by grazing of domestic animals should also be avoided.

Continued next page

EPA Response

① EPA agrees that in comparison to many American metropolitan areas, Metro Denver's cadmium levels are quite low. EPA will also continue to press the District to develop policies that will require industrial pretreatment thus lowering the quantities of heavy metals and toxic organics in the sludge. See discussion under Issue I-1.

② EPA will develop recommendations for the District as to preferred and unsatisfactory uses for the sludge. Your recommendations will be closely followed, particularly in the areas of home gardens, grazing animals, and excessive applications where cumulator crops are involved. See discussions under Issue V-1.

③ Denver sludge would, as the project progresses, be digested anaerobically in its entirety. This should reduce the microbiological hazard, but not eliminate it. According to recent studies, even digested sludges contain ascaris ova (worm eggs) and other pathogens, which may survive on soils and crops for long periods of time. For this reason, sludge should not be used if crops are planted which are eaten raw or are brought into the household or kitchen prior to cooking. Uncontrolled use of sludge may present human health problems, and this is more likely to occur when sludge is sold or given away.

④ In summary, I feel that the following is advisable: 1. To use Denver sludge on land which is owned or leased, so that proper controls can be exercised as to the rate of application, the nature of the crops grown, agricultural practices used, and their timing. 2. Sludge may be sold or given away, if the State of Colorado enacts suitable laws/regulations which will provide appropriate limitations, penalties, controls and monitoring to prevent abuse in all its forms. 3. Further research by Metro-Denver and also efforts by the city to reduce its pollutant inflow are desirable and should broaden Denver's options in this area.

Thank you for the opportunity to comment on this document, and please feel free to contact me if I can be of further help.

Sincerely yours,

George L. Braude

George L. Braude, Ph.D.
Chemical Industry Practices Branch
Division of Chemical Technology
HFF-424

EPA Response

③ EPA will recommend that Metro be required to inform potential users of this hazard. The State of Colorado will have primary responsibility for enforcing regulations on sludge use (see Issue V-4).

④ In regard to the following recommendations, some lands such as parks are owned by local municipalities and can control the rate of application of sludge. However, the bulk of the disposable sludge could end up in private hands. The State of Colorado is in the process of enacting regulations on the use of sludge. EPA will require that Metro dried sludge not be distributed offsite (except where municipalities have control of the sludge), until such time as the State adopts its sludge regulations. EPA will also press the Metro District to reduce its industrial contribution of heavy metals and toxic organics.

Letter #38

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Denver Airports District Office
10255 East 25th Avenue
Aurora, Colorado 80010

[illegible] 5 [illegible]

Regional Administrator
U. S. Environmental Protection Agency
Rocky Mountain - Prairie Region VIII
1860 Lincoln Street, Suite 900
Denver, Colorado 80203

SUBJECT: Metro Denver Sludge Management Plan

Gentlemen:

① We have reviewed the draft environmental impact statement for the subject project and wish to offer the following comments for your consideration.

This agency is participating in the development of a master plan for a new general aviation airport to be located in Adams County. Potential sites for the proposed airport have been subjected to an airspace feasibility analysis and although the site selection is still subject to concurrence of the Adams County Commission, the site located immediately west of the proposed sludge processing and disposal site has been indicated by this agency as being the most desirable of those identified for study.

The forecasts of aeronautical demand to be placed upon the proposed airport, indicate that it should be developed to serve a significant segment of the general aviation activity in the Denver metro and northeastern suburban area. Experience has shown us that airports of this character have a decided attraction for aviation oriented business development and subsequent supportive residential development. This very desirable business development, not only adds to the tax base of the County, but also provides a means by which the airport can become an economically sound public entity which causes no burden upon the taxpayer

It is felt that the proposed sludge processing and disposal site may alter the existing environmental characteristics of the area, for which it is planned, sufficiently to detrimentally affect the development of the proposed airport.

Specifically the feared potential environmental impacts and resultant affects are as follows:

② A. Air Quality: It is feared that the odor produced from the processing and disposal operation will be sufficiently objectionable that the development of business and residential areas in the vicinity of the airport would be depressed.

Continued next page

EPA Response

① The issue of potential land use between the proposed Adams County Regional Airport and the Metro drying site is discussed under Issues II-9 and II-10.

② This issue is also discussed in Issue II-9. There will be some odors as a result of this project operation. However, the drying basins will be located perhaps two miles to the east of the proposed airport site in the direction of the prevailing winds. Stapleton Airport, incidentally, has directly to the east of the east-west runway, a sludge drying area operated by the City Parks Department. Very few odor problems have been noted. We do feel that since the business activity involved with the airport will have most of its interaction with the urbanized area to the west of the airport, such a potential "depression" of business development would be minimal. We were not aware that residential development in proximity to an airport was to be encouraged. EPA still feels that with proper coordinated planning on the airport and sludge site, the open space function of the sludge drying site would be very compatible with airport development.

Letter #38, continued

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③ B. Food Chain: It is feared that the drying beds may have a potential for the attraction of birds which could create a collision hazard for aircraft.

④ C. Natural Environment: It is feared that the high moisture content and heat oxidation may have a potential for the generation of fog or low visibility conditions in the area proposed for siting of the airport.

⑤ D. Construction Conflict: It is feared that the routing of the pipeline to the proposed sludge processing and treatment facility may be in the immediate area of excavation for construction of airport facilities, thereby jeopardizing design features or escalating the cost of construction of airport facilities.

⑥ E. Energy: It is feared that the competitive demand for utilities (water, electrical energy) may be of such severity that airport related business and residential development would be depressed.

We appreciate the opportunity to comment on the subject proposal.

Sincerely,

Robert C Fenley

for EDWARD G. TATUM, Chief
Denver Airports District Office

EPA Response

③ This item is discussed under Issue II-10. The lack of a food source for birds would lessen this possibility. If the FAA still thinks that birds could be a hazard at this site, EPA would be happy to meet with FAA staff to discuss specifics such as required LTO distances & positive prevention steps that could be taken to minimize this hazard.

④ See discussion under Issue II-10.

⑤ Issue I-2 lays out the pipeline routing from the Metro Central plant to the drying site. The pipeline will be laid in the 88th Avenue right-of-way at a depth of 5-10 feet. We do not anticipate that this would cause a problem greater than any other buried utility such as gas lines or water lines.

⑥ The EIS demonstrates that there are sufficient utilities present in the area (roadway capacity, electrical power, etc) to supply the Metro facility. Should rapid development of the airport and urban growth occur in this area, there will have to be wholesale additions of utilities of all forms. We seriously doubt the existing utilities could perform such a service. A description of potential growth trends in the area as predicted by DRCOG to the year 2000 is found in the discussion uder Issue II-4.

Letter #39

BENEDETTI, OPPERMAN & MARTINEZ, P.C.
ATTORNEYS AND COUNSELLORS AT LAW
ONE PARK CENTRAL, SUITE 640
DENVER, COLORADO 80202
(303) [illegible]

PAUL C. BENEDETTI
MARLIN D. OPPERMAN
VIVIAN T. MARTINEZ, JR.
JOHN A. [illegible]

10-4-76
4:30pm

October 4, 1976

Mr. John A. Green
Regional Administrator
U.S. Environmental Protection Agency
Rocky Mountain - Prairie Region VIII
Suite 900
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Green:

This office represents certain persons owning real property located at the proposed B-2 Site for the Metropolitan Denver Sewage Disposal District's proposed sludge processing facility. This letter on behalf of said landowners is intended to be recorded in the official record of the Environmental Protection Agency as a comment upon the Draft Environmental Impact Statement concerning the proposed sludge facility and its site selection.

Mr. Marlin D. Opperman of this office presented an oral statement during hearings held by the Environmental Protection Agency.

The Draft Environmental Impact Statement has failed to fully analyze available data, has failed to properly compare alternative processes and site locations, and has proceeded on the basis of improper comparisons and assumptions. These defects are most clearly demonstrated in the following three aspects of the Draft Environmental Impact Statement.

① First, the draft analyzes and compares only present landfill cultivation operations conducted at the Lowry Site and the proposed B-2 Site. No other methods of sludge processing are thoroughly analyzed in the draft statement, including the method of ultimate disposal. Changes in the thinking of the District as to utilization of the final product have not been analyzed to determine their effect upon site selection.

Continued next page

EPA Response

① EPA's position regarding the evaluation of alternatives (here termed alternative systems of sludge processing) is that all reasonable alternatives should be evaluated. Because the number of systems can get inordinately large with changes in one or more unit processes within an overall system, it makes sense to talk about general approaches. EPA experience has been that it is the sludge disposal (as opposed to in-plant treatment) that results in the potentially greatest environmental problems and also public controversy. Therefore, EPA developed its analysis of overall methods of sludge disposal alternatives; by necessity, the discussions had to be correspondingly general. Options such as composting, land recycling, the present method of landspreading, incineration, and landfilling are the basic ways to dispose of sludge. Table 2 in the EIS (Volume I) identifies the key environmental impacts, engineering factors, costs, and a discussion of institutional ability to implement. At a preliminary level, this kind of analysis can be used to judge the relative merits of these proposals. Since most of these systems are in use at one place or another in this country, it is not unreasonable to assume that any or all of these systems could be used. EPA's nationwide experience is that they can all be used; EPA has never endorsed one particular form of sludge treatment and disposal. Only local variations are likely to make one system preferable to another, such as institutional constraints. In addition, the Metro District has analyzed three different systems in detail—incineration, the land recycling scheme (an earlier version), and the present system of operation. Engineering-Science, the environmental consultant for this EIS, costed out and schematically defined 16 system alternatives that could be used in the Metro situation. Additionally, EPA specifically requested that a promising alternative— that of combining sludge with the DRCOG solid waste proposal— be evaluated. Institutional constraints in this case made the concept unrealistic. The discussion under Issue IV-3, discusses other potential systems suggested in the course of this draft EIS review.

The analysis of sites for the proposed Metro system did identify and comparatively analyze criteria for site selection (see Agricultural Reuse Program, MDSDD #1, March 1973). Additional environmental analyses of the three most preferable sites are also comparatively analyzed (see Appendix G, Volume I of this EIS).

Letter #39, continued

① Without a clear analysis of the alternative sludge processing methods, their environmental impact, ultimate disposal of the processed sludge, and its environmental impact, the Environmental Impact Statement would fail to satisfy the statutory prerequisites for an analysis of project alternatives.

② Secondly, the Draft Environmental Impact Statement has not properly compared the proposed B-2 Site with the Lowry Site. The Environmental Protection Agency should compare sites only after it has fully analyzed the alternative methods of sludge processing. Once a particular process has been settled upon, for instance, the proposed sludge drying beds, all site selection should be evaluated on the basis of the use of that process.

③ The Draft Environmental Impact Statement compares the present landfill cultivation operation conducted at Lowry Site with the proposed drying facilities at the B-2 Site. Neither the Lowry Site nor any other site has been evaluated on the basis of use for the sludge drying facility. Before any proper Environmental Impact Statement may be completed, the alternate sites including the Lowry Site must be evaluated on exactly the same basis and in exactly the same manner as the B-2 Site. Such an analysis should assume utilization of the same technical process at both sites. It should assume collection of the same data on each alternative site. Finally, it should assume the same conclusion that the selected site will not be used for final disposal of the material produced. None of these conditions have been satisfied, and therefore, comparison between the Lowry Site and the B-2 Site is defective and its use as the basis for a Final Environmental Impact Statement would not satisfy standards for such a statement.

④ Thirdly, the Draft Environmental Statement has been issued without analysis of available test boring data taken by the Metropolitan Denver Sewage Disposal District. This data is now available and was just received by our clients and our office on Friday, October 1, 1976. Such data analyzes the soil structure of the proposed B-2 Site and our preliminary analysis suggests that substantial percolation problems may exist and that ground water contamination may be possible at the B-2 Site. This data was available to the Metropolitan Denver Sewage Disposal District at the time that the Draft Environmental Impact Statement was being finalized and printed and that draft should have been delayed until this data could have been evaluated. Because the Metropolitan Denver Sewage Disposal District had full access to and complete control of this data, delaying release of the data until this date sub-

Continued next page

EPA Response

② EPA agrees with your point that the Lowry site should have been systematically compared with the other potential sites for the Metro sludge drying project. This analysis is presented under Issue IV-1. Based on this analysis, EPA thinks that the B-2 is still a better site, but that the Lowry site could be a reasonable option. Institutional constraints, complex land ownership, and higher elevation, all make the Lowry site less favorable than B-2. It should be noted that the City and County of Denver has refused to allow Metro to use the City-owned land at Lowry for the permanent drying facility (see letter # 9).

③ EPA does feel that only the Lowry site, where the existing sludge operation is already taking place, needs to be systematically analysed. Other Lowry options would involve taking new lands, some of which are in private ownership (see discussion uder Issue IV-1 for a map of the existing Lowry ownership).

④ EPA did recognize that there was a lack of soils and groundwater data for the B-2 site analysis; EPA also felt that there was enough uncertainty as to when the data would be available to justify going ahead with the draft EIS. The CH2M-Hill Geotechnical and Soils Report is now available and has been used in the analysis of soils and groundwater at the B-2 site presented in Issue II-1 and Issue II-2.

Letter #33,
continued

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⑤ stantially prejudices the ability of ourselves and our clients to fully analyse this report and make appropriate comments on the Draft Environmental Impact Statement in view of this data.

⑤ Furthermore, no such data has been taken of the alternative Lowry Site. Therefore, a proper soil analysis is not presently available to permit a proper comparison between the B-2 Site and the Lowry Site.

⑥ The Draft Environmental Impact Statement fails to address itself to other applicable governmental regulations affecting the site selection process. This includes other significant environmental implications for future land uses in the general area including industrial and airport uses, and the effect upon developed communities in the nearby area such as Watkins and the town of Bennett. Without an analysis of the complete land use implications of the proposed sites, the Environmental Impact Statement will have failed to evaluate all significant environmental impacts inherent in such a proposed project.

⑦ Therefore, it appears clear to our clients and ourselves that a Final Environmental Impact Statement cannot be prepared or issued until the above studies have been completed. In particular, it seems imperative that the Environmental Protection Agency should include a full analysis of the soil tests taken at the B-2 Site and should require a similar analysis of alternative sites before proceeding with any further revisions of the Draft Environmental Impact Statement.

⑧ Furthermore, wherever the Draft Environmental Impact Statement reflects lack of information available or fails to state the exact basis for conclusions reached, the Environmental Protection Agency should require that the Final Environmental Impact Statement be delayed until such informational gaps are filled.

The opportunity to comment on the Draft Environmental Impact Statement prior to any issuance of a Final Environmental Impact Statement certainly encompasses the right of our clients to have a full and complete opportunity to comment upon the soil test data available to Metropolitan Denver Sewage Disposal District which was made available to our clients October 1, 1976. Metropolitan Denver Sewage Disposal District cannot expect to comply with the requirements of NEPA by releasing essential data at a late date and then hoping that Environmental Protection Agency will proceed according to the most expeditious schedule permitted by statute. The Environmental Protection Agency should

Continued next page

EPA Response

⑤ The Metro District was concerned about potential groundwater and surface water contamination at the Lowry site, and hired the US Geological Survey to do a surface and groundwater study at the Lowry site. The data in the subsequent report does allow a comparison of the Lowry and B-2 sites.

⑥ Effects on adjacent land uses is discussed under Issue II-9.

⑦ EPA has decided to prepare the final EIS on this project, rather than a revised draft EIS. Although review of the final EIS calls for only a 30-day period, EPA will honor any requests during this time period for reasonable additional time to complete a review. EPA will also be willing to meet with interested parties at their request to discuss issues in this EIS.

⑧ Uncertainty exists at all levels of understanding; this is particularly true in the field of environmental impact evaluation. EPA feels that its responsibility is to make the decision-makers and other readers aware of where areas of uncertainty exist. However, a decision must still be made whether or not to proceed based on the current state of knowledge. In this case, areas of uncertainty are spelled out in the discussion under Issue II-11. EPA feels that the project will still meet its principal objectives given the proper mitigation measures (such as basin lining). Other areas of uncertainty include political-institutional ones such as the review by the County for a Site Designation Permit. EPA sees no particular merit in waiting, given the lack of initiative by the District or the County to begin this process. If after such a review, the project is deemed infeasible for one reason or another, EPA will be willing to consider other alternatives. This EIS can provide technical information that may be helpful to other decision makers in deciding the fate of this project.

Letter #23,
continued

Page 6
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require the Metropolitan Denver Sewage Disposal District to await EPA determination until such time as EPA has received all of the data necessary for evaluation of the proposed sludge drying facility and has evaluated all soil tests necessary for proper site selection.

Very truly yours,

John A. Meininger

John A. Meininger

JAM:cr

Letter #40

BOARD
OF
COUNTY COMMISSIONERS

COMMISSIONERS
John G. Campbell
Pete M Mirelez
James M. Covey

CLERK OF THE BOARD
William Zadel

ADMINISTRATION BUILDING
450 SOUTH 4TH AVENUE
BRIGHTON, COLORADO 80601
659-2120

October 6, 1976

Mr. John A. Green, Regional Administrator
United States Environmental Protection Agency
Region VIII, 1860 Lincoln Street
Denver, Colorado 80203

RE: Draft Environmental Impact Statement on Management Plan for Wastewater Sludge by Metropolitan Denver Sewage Disposal District No.1, Denver, Colorado. EPA Project Number: C0080341

Dear Mr. Green:

① Any determination of approval or disapproval of the above referenced project by the Environmental Protection Agency (EPA) should be withheld until the Adams County Board of County Commissioners have made a decision on a certificate of site designation pursuant to 30-20-102, Colorado Revised Statutes 1973, as amended. It is felt that EPA should be aware of local considerations and decisions on this project to adequately assess all impacts.

The agricultural reuse proposal of the Sludge Management Plan for Metropolitan Denver Sewage Disposal District No.1 (Metro) raises serious potential environmental concerns for Adams County. With proper control and mitigation procedures, the use of sludge for agricultural purposes could be a beneficial use. However, the Environmental Impact Statement (EIS), demonstrates that insufficient knowledge of hazards is available at this time and that adequate management and control systems have not yet been delineated.

There are several concerns with this project which the EIS does not adequately answer:

② 1. A management/inspection program has not been developed to insure that proper controls are used to prevent misuse (over-application) of sludge material and to inspect disease dangers. Also, cessation procedures need to be prepared should noncompliance occur. Who will provide these services and how will it be paid for?

Continued next page

EPA Response

① EPA considered the possibility of awaiting such a site designation process before issuing the final EIS. We have, however, decided to release the final EIS for a number of reasons. For one, there has been no action on the part of Metro District or the County to begin a formal proceeding on this issue. More importantly, EPA thinks that since the EIS has been prepared with a great deal of technical information, such information could be of value in making decisions about the project. We also think that since the impact issues on this project are now fairly well defined a reading of this final EIS will be helpful in determining how some of the impacts can be minimized through mitigating grant conditions, and whether the resulting project is acceptable. EPA will not fund Step II (design) or Step III (construction) phases, unless the Site Designation process has been satisfactorily resolved. We shall closely consider the decision of the County Commissioners on this action. Should the turn of events so dictate, EPA would be willing to perform supplementary EIS work. EPA is highly sensitive to local concerns on this project; we shall be guided to a large extent by those decisions.

② A discussion of management and control of sludge applications is presented under Issue V-4. State regulations are currently being developed; EPA will require Metro to agree not to disseminate dried sludge except on city-owned lands, until such time as these regulations are finalized.

Letter #40, continued

③ The very real problem of dangers from improper management is recognized on page 9, and elsewhere in the E.I.S. The E.I.S. stresses that it is a very important and implicit assumption that sludge application rates be adhered to by the recipients of the materials. As such adherence can not be guaranteed and to the extent that recommendations are not followed the number and severity of impacts will increase. The very fact, that no prodedures have been enumerated to establish management/control systems to monitor possible misuses is cause for concern. On pages 147 and 184 it is suggested that record keeping, inspection of sludge application operations on individual sites and monitoring of environmental parameters are functions which must be carried out by Metro or another responsible agency. It is further suggested, that it would be adviseable to establish binding agreements permitting monitoring and inspection and to provide for cessation of sludge supply in cases of noncompliance. These procedures have not been established and are not envisioned in present plans (page 192) and may be difficult to obtain from the farm owners without interferring with the farmer's operating rights. The monitoring and control program has not been sufficiently developed or analyzed. It is doubtful that it would be acceptable for Metro to provide these functions and, this raises the questions of who would and how would it be paid for to insure unbiased management. It would be difficult to accept the sludge reuse proposal without an adequate and acceptable management/inspection/cessation plan.

④ Continuing with the management/inspection situation it would appear that even if a mechanism were established, it would create a very significant inspection and records keeping system which could easily result in inadvertent errors, resulting in significant environmental or health problems. On page 145, it is recognized that the public health department would have increased monitoring activities to cover all the land recycling areas receiving sludge. Can the health department adequately increase its manpower requirements and how should this rightfully be paid for? On page 81 health concerns with the project is assigned to the Tri-County District Health Department, but there is no indication as to whether or not they would be able to establish the manpower requirements generated by this additional responsibility.

Pathogen problems appear to be low while salts accumulation problems are high but, to a significant degree depend upon proper management and operation procedures. Stronger evidence of proper health inspection, management, and operation procedures should be provided.

⑤ 2. Since federal grant funds are currently unavailable Metro should demonstrate how it will fund the project?

Much of the capital cost of the project would be from a 75% grant through the Environmental Protection Agency (EPA). Since there are currently no funds available for this type of project (page 10) it should be necessary for Metro to demonstrate how it would fund this project should funds not become available. This does not

Continued next page

EPA Response

③ See discussion under Issue V-4. EPA recommendations to Metro are contained in Appendix A of this Volume.

④ This problem will have to be worked out with the State, which has primary enforcement responsibility. Perhaps with close cooperation with the Metro District, voluntary reporting and mutually acceptable policies on sludge use could lessen this burden.

⑤ The draft EIS reported that at that time, no federal funds were available for construction of this project. Since that time, Congress has authorized additional monies that could be used. In addition, Congress is now contemplating long-term future authorizations of money for wastewater treatment construction as high as $45 billion dollars over the next ten years. The likelihood is now high that this project would be paid for with federal funds upon approval of the facilities plan.

Letter #40,
continued

Mr. John Green
Page 3

⑤ appear in the report.

⑥ 3. Detailed information on soil conditions and groundwater depth and quality at the distribution center should be essential to insure proper design of the facility.

The Lost Creek Groundwater District has indicated opposition to this
project because it would pollute their system and be contrary to
their management criteria. The Lost Creek Basin has been described
as a closed basin with many intermingling aquifers. Only fresh
water recharge is allowed in the District and no other sources should
be injected into the basin. To avoid contamination, a soils anal-
ysis is essential. Much of the processing site area is to be
used for marketing, research, and demonstration plots to test var-
ious sludge loading rates. Subsurface injection rates as high as
300 tons per acre would be used should insufficient markets develop
(page 86). Such high rates would eventually contaminate the closed
basin which is in conflict with the management criteria of the
Water District. The project does need to take this into consider-
ation. Since the test plots are considered an important part of the
project the inability to use the test plots would make a significant
change in the project design, and this problem needs to be investigat-
ed. The project, if approved, would need sealed drying basins and
bentonite would not be acceptable because it would be damaged when
the dried sludge was removed from the drying beds. Sealing with
concrete may be an acceptable method, but for 600 acres this would
be extremely expensive. This expense has not been included in pro-
ject costs as a possible alternative. Monitoring systems placed
under the drying beds to detect pollution would provide a warning
which may be too late. Even if Metro were to pump the polluted
water out, some would get past and then there is also the problem
of what to do with the pumped out water since it could not be re-
moved from the Water District.

⑦ Detailed information on soil conditions and groundwater depth and
quality is not available for the distribution center site (page
28 and 29). This information should be considered essential prior
to any decision and could have major impacts on the design of the
disposal system. Some soils testing has recently been done by
Metro, but this information has not been made available to other
agencies. It is requested that Adams County be provided with all
pertinent information so that it can be analyzed by the County.

⑧ 4. The project would cause degradation of groundwater which may be in direct conflict with CRS 25-8. The issue of whether or not the high levels of groundwater degradation at the distribution center and the lower levels at individual user sites would be acceptable under CRS 25-8 has not been addressed.

⑨ Perhaps the most significant impact is the inevitable degradation of water quality by nitrates to a degree that would make groundwater unacceptable as a source of drinking water (page 29). This environmental impact should be sufficiently objectionable to consider this project unacceptable. Denitrification mitigation is unknown for the sites (page 29) and definitely needs to be resolved before

Continued next page

EPA Response

⑥ A detailed discussion of the existing groundwater situation in the vicinity of the B-2 site is presented in Issues II-1 and II-2. EPA recognizes the valid concern of the Lost Creek Groundwater District in wanting its ground and surface waters protected. EPA will therefore require the Metro District to provide a lining of specified thickness and permeability. This information is presented under Issue II-2. A discussion of alternative lining methods is presented in Issue IV-2.

⑦ Some of the soils and groundwater information developed by CH2M-Hill for the B-2 site is presented in Issues II-1 and II-2. Copies of the original reports will be made available to the County upon request.

⑧ EPA believes that groundwater contamination at sludge use sites, given proper application rates based on available nitrogen, will not cause groundwater problems. At a minimum, problems should be no worse than that experienced from present fertilizer applications.

⑨ Permeability calculations for the lining at site B-2 have been made with drinking water standards in mind. Metro will also be required to submit a groundwater pumping plan in the event that monitoring in and around the site indicates a pollution problem. Extensive monitoring will also be part of the Metro operation, run by the US Geological Survey (see Appendix D).

Mr. John Green
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Letter #40
continued

finalized design of the drying basins. Current design does not include lining of the drying basins to prevent percolation (page 110) and it is merely suggested that it may be necessary to do so (page 111). Cost estimates of such a procedure are not provided. Since the degradation of groundwater may be in direct conflict with CRS 25-8 it would appear that measures need to be taken to prevent this from occurring. The Colorado Water Quality Control Commission is currently considering specific standards for groundwater contamination. As the contamination potential is greatest at the drying basins this should be of major concern. Mitigative measures for slowing leachates from moving to the water table on page 181 are not sufficient. On page 185 it is also recognized that the leaching process can only be slowed and indicates that applications would have to stop when concentration become too high and that potable use of water would have to be restricted. Mitigation procedures need to be established to prevent the loss of potable water, by establishing much lower permissable levels of application. Off site contamination is also inevitable although to a lesser degree and over a much longer period of time. However, the issue of whether or not these levels would be acceptable under CRS 25-8 has not been addressed.

5. More definite scheduling of operation procedures should be provided.

The actual time necessary to allow for drying of sludge in the basins is not precisely known (page 31) and this could have significant impacts on the designed staging of the facility. This ties in with points 3 and 4 concerning the need for lining the drying beds. As one of the factors in drying the sludge would be percolation the use of concrete to line the beds would have an effect on the drying times. The incorporation of drainage tiles in the concrete system would greatly increase costs which have not been calculated. At the designed application depths of 24 inches (page 97) it is probable that crusting would occur. This would have an inhibitory effect on the drying rate through evaporation and increase percolation needs. In addition, the potential for the creation of odors would increase. Careful investigation of calculated drying rates and odor problems should be made. The dried sludge would be stockpiled until used and it is indicated that to prevent the blowing of the material during high winds that a spraying system would be provided to wet it down. There is a definite concern that this would not work as well as planned and that significant blowing would occur posing health dangers over a large area. Since the occurrence of strong winds could not be predicted far enough in advance, it would probably not be possible to adequately schedule wetting times. Another concern is the potential of salts accumulating on the surface and being blown onto surrounding lands. Information on the degree of salts deposits subject to blowing is not provided and should be investigated.

A significant concern was expressed during the public hearings concerning the drying periods for the sludge. It was felt that during

Continued next page

EPA Response

⑩ EPA feels that groundwater pumping as a backup system is feasible because of the geological configuration under the site. Test borings have indicated that for the most part, a very impermeable layer of siltstone and claystone underlies the 1 to 6m [2 to 20 feet] of soil material. A perched aquifer would likely develop over this impermeable layer, allowing for removal of contaminated water by pumping. The possibility does exist that on at least a small portion of the site, the bedrock may be as porous or more permeable than the overlying materials. In this case, no perched aquifer would form. The area identified lies in the northwest corner of the site, near the location of the catchment reservoir. Here, however, water quality from the runoff reservoirs may still meet drinking water standards after percolation. A final consideration is that in the relatively low-probability event that some leachate does reach an aquifer, the relative volumes of leachate to native groundwater flow will determine the final concentrations. In this case, only nitrates and salt concentrations would be of concern; pathogens, solids, and organic contaminants would be essentially removed by the soil filtration process.

⑪ In the discussion of basin drying capacities, EPA concludes that the design is probably conservative, and that there is sufficient capacity to handle 1985 design year sludge flows. We do agree that lining of the basins could have an effect on overall drying times. Metro's experiments at Greeley indicated that very little percolation water moved beneath drying beds containing a relatively sandy soil. Metro concludes that rapid sealing of the soil layer took place. Similar data from the San Jose, California drying basins indicates that drying times comparable to Metro's were experienced in an area of shallow groundwater and clayey soils. The operators at San Jose indicated that at times groundwater may actually flow into the drying basins (Reference 24). Metro plans to use equipment on the drying beds to break up the surface crust periodically.

⑫ Discussions on odor (Issue II-3) and windblowing (Issue II-5) should be consulted. Salts are not present in high enough concentrations to blow; the salts are interspersed in the dried sludge.

Mr. John Green
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⑬ a wet year the stockpiled material would absorb water and prolong the drying periods. Metro indicated that the water would be shed off the piles while EPA's consultant felt the material would absorb water. This concern was not addressed in the EIS and should be investigated.

6. Insufficient knowledge of dangers from heavy metal accumulation in the human food chain is of concern.

⑭ The uptake of heavy metals by plants grown on sludge distribution sites varies with the type of plant and the growing conditions. Additional information is needed to better understand the impact of heavy metals, particularly nickel and cadmium. The U.S. Food and Drug Administration has yet to promulgate guidelines for control of levels of possible harmful substances in sludge applied to crops which enter the human food chain (page 87,112). Suggested loading rates in the project attempt to be cautious but the safe levels still are an unknown. One mitigation procedure for safety of meat from animals grazed on or fed from sludge grown crops would be to dispose of the kidneys and livers which are organs of metals concentration . The economic impacts of such a loss are not included (page 184).

⑮ House Bill 1191 amended 30-20-102, CRS 1973 to permit the beneficial use of sludge which has been processed and certified or designated as meeting all applicable regulations of the Department of Health and the Department of Agriculture. Without the existance of such regulations establishing safe standards there can be no market for the dried sludge.

7. There may be conflicts with the proposed Adams County General Aviation Airport caused by insect nuisance and the attraction of birds which could cause accidents with aircraft. Concern also exists with the compatability of desired industrial development around the airport.

⑯ The report suggests (page 93 and 126) that the sludge drying site would be compatible as a land use with the proposed Adams County General Aviation Airport which may be in close proximity. A recent concern expressed in a letter dated June 17, 1976, to Mr. John Green, Regional Administrator, EPA, requests assistance in evaluating the possible impacts of insects breeding at the site and causing a nuisance in themselves as well as attracting birds which could cause accidents with aircraft. The evaluation of compatibility of the sludge site with off airport growth such as for industry is also being evaluated. From a point of view of creating a clear zone for the aircraft and reduction of residential pressures, the sludge site may be a benefit to the proposed airport, but this needs to be re-evaluated in light of the concerns expressed in the letter to the EPA.

The Phase II portion of the airport study is to evaluate the potential site alternatives, environmental impacts and recommend the best site. Significant analysis has been accomplished to date and the Federal Aviation Administration has evaluated the site alter-

Continued next page

EPA Response

⑬ Occasional wetting of sludge is not believed to present a problem. Overall dryness greater than 40-50% can be achieved. Water added to this material simply results in a damp, spongy material that is more stable.

⑭ Discussions on heavy metals limits on sludge use is presented under Issues V-1 and V-4; discussion on source control of heavy metals at Metro is presented under Issue I-1. The FDA did provide a letter of comment (see letter # 37).

⑮ As stated elsewhere, EPA will not permit Metro to disperse sludge until State regulations on use of sludge are finalized.

⑯ EPA maintains that the sludge site and the airport can be compatible land uses. This issue is discussed under Issue II-9 and Issue II-10.

Letter #40, continued

⑯ nations indicating that site B is the most desirable of the three locations. This is located approximately two and one half miles west from the western edge of the sludge drying site. However, a determination by the County as to which site will be selected is still pending. After a site selection is made this will only determine which site will be given full investigation and does not mean that a decision to develop an airport has been made.

⑰ 8. Metro's management plan should include Metro obtaining development rights in a buffer zone of at least 2 miles in all directions around the distribution center to protect the public from potential hazards from insects, pathogens and water pollution.

Consideration of the location near the proposed airport brings to light a point for consideration that is not addressed in the report. It is suggested that some procedure be established to maintain a buffer zone around the sludge site of perhaps 2 miles in all directions to prevent conflicts. This may be through the obtaining of development rights.

⑱ 9. The design life of the project may appear acceptable but the long term implications of the project on soils and groundwater are significant and of great concern. Sufficient information on long term impacts is not provided.

The report itself asks a very important question which is not adequately addressed, it summarizes a major long term concern for environmental impact. "The land recycling proposal by Metro will probably have a duration of 25 to 50 years. This is a rather long period of time, given the rapidity of change in today's society. Nevertheless, it is a fair and important question to ask what the implications of the project may be for the next few hundred years with regard to the soils." (page 194)

⑲ 10. Further investigation of incineration of non-anaerobically digested sludge with solid wastes or with coal should be attempted considering the increasing value of energy resources. Although current legislation is not amenable to this the long term nature of this project may make this alternative more feasible within a reasonable amount of time.

⑳ On page 9, a trucking distance of 60 miles for air-dried sludge for land application is established as cost effective. Although, it would appear there should be adequate land area to dispose of this material, there have been no preliminary agreements established to determine how many users and how much land would be available for application. The report does not attempt to investigate alternative sludge handling systems should there not be an adequate market and states on page 7, that at worst Metro could dispose of the dried sludge in a sanitary landfill. This would add significant costs to the project and introduce additional environmental issues. Considering the capital costs of the project ($25.9 million, page 9) it would be logical to investigate the impacts if no market developed and the possibility of a different project design. As part of the

Continued next page

EPA Response

⑰ Given the present configuration of land uses, EPA feels that this measure is presently unjustified. The airport preferred site is approximately 3km [2 miles] from site B-2; perhaps County planning could determine how future industrial patterns develop in the airport vicinity. EPA feels that residential development is not a particularly desirable feature near an airport.

⑱ While this is technically true that such long-term implications have not been carefully researched, other sludge application experiences lead EPA to believe that the long term soil prospects are favorable. Micronutrient additions to the soil are important; as long as application rates are kept at a reasonable level, we have no reason to believe there will be any untoward effects on the soil. See discussion under Issue V-5.

⑲ These alternatives have been investigated in the draft EIS. There is still no movement in the Denver metropolitan area to develop such solid waste schemes. EPA does encourage such combined uses, but at present there are not sufficient funds to federally sponsor such projects. Sludge may also not be compatible with some of these schemes, such as supplemental power plant fuel.

⑳ The cost of landfilling the dried sludge if adequate markets do not develop is estimated to be $3.58/mt [$3.25/ton] for hauling costs, in addition to landfill charges. Even if this is necessary, the sludge disposal will be cheaper overall than the current disposal method. See Issue II-15.

Letter #[illegible]
continued

Mr. John Green
Page 7

National Environmental Policy Act, it is necessary to investigate reasonable alternatives which may reduce negative environmental impacts (page 11). One alternative, has been investigated by the Denver Regional Council of Governments, in the form of a solid waste incineration plan, incorporating the sludge as one of the materials but this has not been approved by the State as a possible program at this time. Perhaps if Metro finds that its current project will not become reality and would assist in lobbying this approach, a new perspective may be achieved. Although, unproven and perhaps technically not feasible, another possible uninvestigated alternative would be solar incineration of the material, which may not have the air pollution problems associated with other incineration methods. Pyrolysis was investigated in the study but analyzed as costly and experimental. It is felt that pyrolysis in the long term may be more economical and beneficial considering the many negative environmental impacts of the current proposal. It is reported in the August 1976 issue of Planning Volume 42, Number 7, page 13, that the use of the pyrolysis method is advocated by the Interstate Sanitation Commission for application to New York City's sludge. Since the pyrolysis process involves a combustion process that would burn the sludge without oxygen or emissions into the air and convert it into useful methane gas it would appear that more investigation into this method is justified.

The current proposal envisions using the mesophilic process in the anaerobic digestion process whereas the thermophilic range results in a better stabilized sludge which is more easily dewatered and reportedly has a greater pathogen reduction. EPA states that it intends to evaluate this alternative (page 23) and this information should be made available prior to any decisions.

Considering the controversial nature of site selection, EPA has suggested that further investigation of alternative sites be attempted. One possible location is the Lowry Bombing Range as the drying distribution center (page 37). Since EPA finds no overwhelming superior site location (page 38), it appears that more emphasis should be placed on the benefits to be derived from alternative site location. Considering the many unresolved problems of this project it perhaps would be desirable for the second alternative of some modified type of drying/windrowing operation at the Lowry site as suggested on page 33 to be used.

11. Further investigation of the effects of the sludge to dryland farms is suggested.

During the public hearings there were several individuals that strongly spoke of the dangers of crop damage with the application of the sludge. The concern was that in the dry climate of this region the crops would have inhibited growth and actually burn due to the lack of sufficient rainfall at proper intervals to compensate for the fertilizer actions of the sludge. Additional investigation of dryland farming characteristics is warranted.

Continued next page

EPA Response

㉑ Alternative sludge processing techniques are discussed in Issue IV-3. The conclusion at this stage is that the systems listed are either too unproven or are inferior to the proposed system. Thermophilic digestion is an option that is still open to Metro; however, it does not affect this project as the remaining sludge must still be dewatered and disposed.

㉒ The use of the Lowry site is discussed in more detail in Issue IV-1.

㉓ EPA now believes that dryland farms will not be large consumers of dried sludge. In any case, if sludge is applied to dryland farms in amounts based on supplying the crops' nitrogen requirements, adverse effects on crop development is not expected.

Letter No. [illegible]
continued

Mr. John Green
Page [illegible]

It is the opinion of the Adams County Board of County Commissioners that the EIS does not adequately address many significant environmental concerns and the management plan of the proposed project is ineffective. The current Metro proposal should not be approved by the EPA.

Yours very truly,

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JAMES [illegible]
CHAIRMAN

Letter #41

TYPED FROM HANDWRITTEN LETTER ON KALCEVIC FARMS, INC.
LETTERHEAD.

Page 1.

United States Environmental Protection Agency
Mr. John A. Green
Regional Administrator

Dear Mr. Green:

My name is John G. Kalcevic, President of Kalcevic Farms, Inc. of Bennett, Colo. and am concerned about having any proposed Metro Denver Sludge treating plant being located in Adams County.

We own the S.E. 1/4 of Sec. 27 T2S-R65W Adams County which is located on the East line of Proposed Site B-2, also own S.W. 1/4 of Sec. 30 T2S-R65W located 1/2 mile West of Proposed Site B-2.

① As outlined in the Environmental Impact Statement there is no provision to keep the dryed soluble salts from blowing on the farm land located around either of the proposed sites.

During high Colorado wind periods the dryed soluble salts will blow at least 5 to 10 miles from any of the proposed sites, and will salt the soil to a point that will kill any growing grain crops within 5 miles of the proposed sites.

Therefore Metro Denver should be forced to purchase at a 5 mile buffer zone around any site selected by Metro Denver.

You will note the following information given in the Ohio State University Bulletin #598 on land application of sewage sludge.

Page 6. Biological Characteristics -

② Various pathogenic microorganisms which may cause diseases such as Cholera, typhoid, tetanus, and dysentery may be present in sewage sludge as it is applied to the land. These organisms are associated with fecal waste and some of them will survive conventional sewage treatment processes. Additional treatments which would destroy almost all pathogens are:

1. Storing in lagoons for long periods of time.
2. Pasteurizing at 70°C for 30 minutes.
3. Adding lime to raise the pH of the sludge to 12.4.
4. Chlorinating or other chemical treatment.

Continued next page

EPA Response

① Because of the way in which the sludge dries, it is unlikely that there will be any significant movement of soluble salts apart from the dried solid material. If the sludge were to be pulverized, this could occur; as long as the sludge remains intact, there should be little or no blowing of salts from the sludge (see discussion on windblowing, Issue II-5). We cannot agree that on the basis of this issue, that Metro should be required to purchase a 5 mile buffer around the site.

② Air-drying is also an effective way to reduce pathogenic microorganisms concentrations in sludge. A few pathogens are long-lived, particularly in spore or egg forms (such as *Ascaris*). Page 114 of Volume I of this EIS identifies these organisms and their reported survival times in various media such as soil or on plants. The combination of sunlight radiation, heat, and dryness should reduce or eliminate most pathogenic organisms. A more detailed discussion of this issue is found under Issue V-1.

Letter #41
continued

Page 2.

United States Environmental Protection Agency

However, most cities do not employ these processes. Furthermore, no process will kill 100 percent of such disease organisms.

Page 6.

③ Most sludges are high in soluble salts, and although this should not be a major problem in high rainfall areas like Ohio, salt accumulation could be a problem in depressional areas.

If you study the Ohio Bulletin 598 seriously you will conclude that Eastern Colorado with 10 to 12 inches of rainfall per year is no place to add sewer sludge to the land.

④ The most feasible and economical way for Metro Denver to dispose of the Metro Sewer sludge is to haul or pump it to the present bombing range.

⑤ But if Metro Denver is determined to spend the taxpayers money is to build an underground sewage sludge disposal plant as they do in Sweden.

I have not met anyone who wants the Metro Denver to dump sewer sludge in Adams County in any form whatsoever.

We do not want any sewer sludge on our farm in any form of sludge or fertilizer.

We urge the United States Environmental Protection Agency to disapprove any and all proposals of Metro Denver Sewage disposal District #1 to dump any sewage in any form in Adams County.

Sincerely yours,

Kalcevic Farms, Inc.

By John G. Kalcevic, President

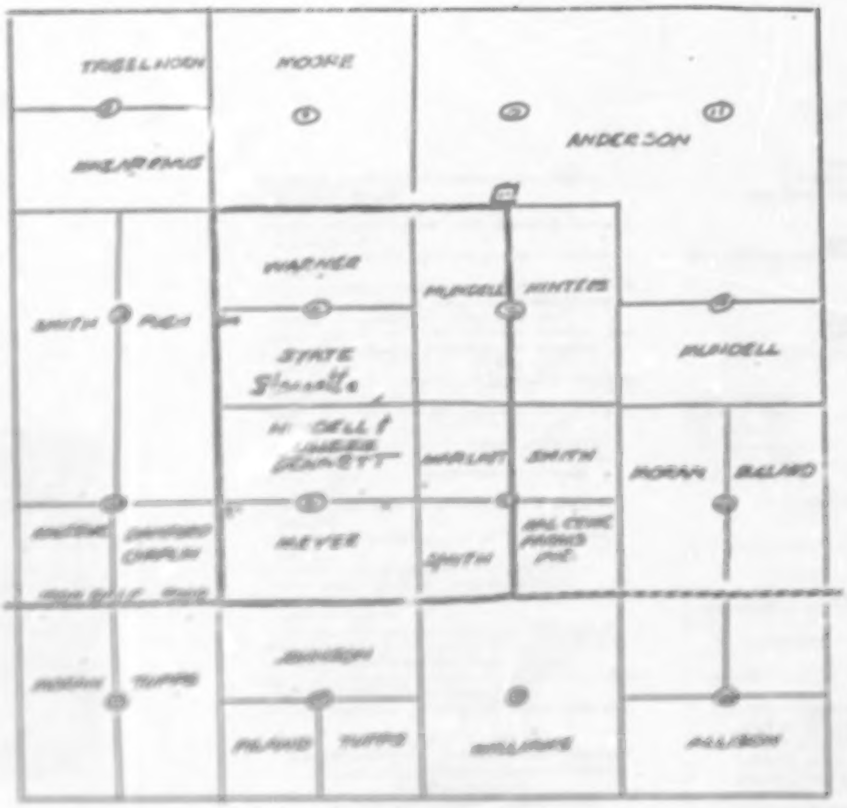
EPA Response

③ The types of constituents in the soluble salts associated with Metro sludge are discussed under Issue V-1. A substantial percentage of the salts are nutrients, similar to soluble salts in fertilizer.

④ Discussions about the present system of operation at Lowry Bombing Range are covered under Issue III-1; an analysis of the potential use of Lowry Bombing Range for this proposed drying project is found under Issue IV-1.

⑤ A discussion of the "Swedish system" is found under Issue IV-3. It would not be applicable for large-scale wastewater treatment in the Metro area.

Attachment to
Letter #41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OWNERSHIP
SLUDGE DRYING SITE
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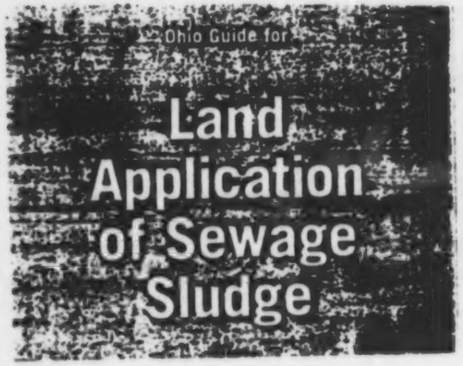
Attachment to
Letter #41



TASK FORCE
ON
LAND APPLICATION OF SEWAGE SLUDGE

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July 1975

Continued next page

OHIO GUIDE FOR LAND APPLICATION OF SEWAGE SLUDGE

REPORT OF THE TASK FORCE ON LAND APPLICATION OF SEWAGE SLUDGE

An increasing number of landowners, local officials and other citizens have been asking questions about the application of sludge to farm land. Sludge has been applied to land for a number of years in some communities. However, recent action by the U.S. Environmental Protection Agency, increased costs of fertilizer, and a concern for efficient energy utilization have generated further interest in the handling of sewage sludge.

On one side of the coin, *municipalities* are faced with the problem of how best to dispose of sewage sludges that are produced by the urban and industrial segments of society. Disposal of sludge by current incineration and landfill operation methods now used by most communities has raised serious environmental concerns.

Landowners, though, are concerned about the feasibility of applying sludge to their land. While interested in the economic benefits sludge may have, they are, at the same time, concerned with questions related to application rates, potential hazards of heavy metals, possible odor problems, and health hazards that might be associated with sludge application.

The following guidelines are based on the most recent research information available, and are subject to change as additional research is completed. It must be clearly understood that the information does not indicate what may or may not be acceptable from a regulatory standpoint. Any regulations governing the application of sludge will be developed by the U.S. Environmental Protection Agency or Ohio Environmental Protection Agency and local health departments.

The basic intent of this publication is to assist landowners in making decisions as they consider application of sludge to their land. Further, the content should help local officials understand the limitations and capabilities of soil as a means of sewage sludge disposal. The publication also provides factual information for the general public concerning the nature of the sludge product and its disposal.

A question frequently asked is, "How many tons of sludge can I apply to my land?" It is impossible to answer that question until two prime factors are known: the composition of the sludge, and the physical and chemical properties of the soil. So, before a recommendation can be made, it's necessary that the results of the sludge and soil analyses be available. Then, through the formulas detailed later in this publication, it will be possible to recommend safe limits of application for given sludge, soil, and cropping situations.

CHARACTERISTICS OF SLUDGE

Sewage sludge characteristics may be categorized into physical, chemical, biological, and "nuisance". The characteristics depend on the type of sewage and the sludge treatment processes. Terminology is related to the type of treatment process.

Terminology

Two broad classes of sludge are: 1) untreated (raw), and 2) treated. **Primary sludge** is raw sludge obtained in the primary stage of the treatment plant by collecting settleable and suspended solids. **Activated sludge** is obtained in the secondary stage of the treatment plant by settling flocculated bacteria cells that have been feeding on the soluble and suspended organic material in the sewage. Primary and activated sludges are further treated to obtain a **stabilized sludge** in which the organic matter has been decomposed into a relatively stable material. Anaerobic digestion, a common method of stabilizing sludge, produces **digested sludge**. Sludges may also be stabilized by thermal conditioning (wet oxidation) or lime stabilization. Chemical precipitation, gravity, and air flotation processes are used to **thicken** sludge. Vacuum filters, centrifuges, and filter presses are utilized to **dewater** sludge. Sand drying beds, or dehydrators, may be used to produce a **dried sludge**.

Physical Characteristics

The principal physical characteristic of sludges affecting handling and land application methods is the solids content or the related moisture con-

Continued next page

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tent. If a sludge has 5 percent solids, it is 95 percent water. Three ranges of solids content that relate to different handling methods are shown in Table 1.

Table 1. Sludge Solids Content and Handling Characteristics

Type	Solids Content	Handling Methods
Liquid	1-10%	Gravity flow, pump, tank transport
Semi-Solid ("wet" solids)	10-30%	Conveyor, auger, truck transport (Water-tight box)
Solid ("dry" solids)	25-80%	Conveyor, auger, truck transport (box)

There is an overlap of solids content for the types noted due to characteristics of particular sludges and handling equipment. Normally a sludge with over 10 percent solids will not flow by gravity through a six inch pipe.

Chemical Characteristics

Organic matter content, fertilizer nutrients, and trace elements are the chemical components of concern. Tables 2 and 3 present their range of concentration in sewage sludge. There is great variability due to the sources of sewage and types of treatment. There are also other trace elements present which are not listed in Table 3.

Biological Characteristics

Various pathogenic microorganisms which may cause diseases such as cholera, typhoid, tetanus, and dysentery may be present in sewage sludge as it is applied to the land. These organisms are associated with fecal waste and some of them will survive conventional sewage treatment processes. Additional treatments which would destroy almost all pathogens are:

1) Storing in lagoons for long periods of time.
2) Pasteurizing at 70°C for 30 minutes.
3) Adding lime to raise the pH of the sludge to 12.4.
4) Chlorinating or other chemical treatment.

However, most cities do not employ these processes. Furthermore, no process will kill 100 percent of such disease organisms.

The level of pathogens in digested sludge is low, but care should be taken in handling. It is not practical to disinfect sludge prior to land application because of the organic matter present. Recent studies have shown that when sludge is applied to land, microbes are retained at the soil surface and soon die. Therefore, the presence of some pathogens in the sludge should not limit land application of digested sludge. But sludge should not be applied to land during the year when crops are to be grown for raw consumption.

Table 2. Range of N, P, and K Contents of Sewage Sludge

	Range	
Component	%	lbs/ton
Total Nitrogen	3.5-6.4	70-128
Organic Nitrogen	2.0-4.5	40-90
P (Phosphorus)	0.8-3.9	16-78
P_2O_5 (Phosphate)	1.8-8.7	36-174
K (Potassium)	0.2-0.7	4-14
K_2O (Potash)	0.24-0.84	5-17

Table 3. Trace Element Concentrations in Sewage Sludge

Element	Range (ppm*, dry wt.)	Median**
Boron	6-1000	50
Cadmium	1-1500	10
Chromium	20-40,600	200
Cobalt	2-260	10
Copper	52-11,700	850
Nickel	10-5300	80
Manganese	60-3900	260
Mercury	0.1-56	5
Molybdenum	2-1000	5
Lead	15-26,000	500
Zinc	72-49,000	2000

*Parts per million
**The median is that value for which 50% of the observations, when arranged in the order of magnitude, lie on each side.

"Nuisance" Considerations

Odors are the primary nuisance involved with land application of digested sludge. It is recommended that only digested or stabilized sludge be applied to land.

Odor nuisance can be minimized by management decisions. Spreading should be at least 250 feet from the nearest residence. If large quantities are spread in a short period of time, the distance may need to be increased. If sludge storage lagoons are located in the area of application, they will need to be at least 1500 feet from residences.

Management

Site Selection

The primary reasons for applying sewage sludge on agricultural land are to use the nutrients contained in sludge for crop production and, at the same time, to minimize the environmental objections of sludge disposal. In order to do this, attention must be given to the landscape and soil characteristics of the application site. Suitability of

Continued next page

sludge and rates to use will depend on the heavy metal content of the sludge. In the absence of high concentrations of heavy metals, nitrogen and phosphate contents of sludge can limit the amount that should be applied.

The ideal site is one in which sludge materials can be utilized by crops and which will allow no movement of sludge components from soil as runoff or leachate.

The primary site criteria to be considered are landscape features, along with chemical and physical properties of the soil:

Landscape Features:

Slope: Sludge should not be spread on slopes greater than 12 percent. On 6-12 percent slopes, spread only when at least 80 percent of the soil is covered with vegetation, when immediate incorporation is possible, or when erosion control meets recommendations in Ohio Erosion Control and Sediment Pollution Abatement Guide, Cooperative Extension Service Bulletin 594.

Proximity to Water: Sludge should not be spread within 300 feet of ponds, lakes, or drainage ditches.

Flood Hazard: Sludge should not be applied to soils which are subjected to periodic flooding greater than 10 percent chance per year.

Shallow Soils: Sludge should not be applied to soils less than five feet thick overlying fractured bedrock or permeable sands or gravels because of the potential leaching of soluble components of sludge into groundwater.

Water Table: Sludge should not be applied when a perched water table is within a foot of the surface. Soils with high permanent water tables should be avoided or a drainage system should be installed.

Seepage: High rates of sludge application should be avoided on land with pronounced lateral seepage.

Soil Properties:

Chemical:

pH: The pH of the plow layer (0-8") should be near 6.5. Toxic heavy metals are more available to the plant at low pH's. Soil pH's much higher or lower than 6.5 will reduce the ability of microorganisms in soil to decompose sludge.

Cation Exchange Capacity (CEC): Soils with higher cation exchange capacities have division of greater ability to hold and immobilize heavy metals. The equation given in the heavy metal section relates sludge loading rates to CEC. Cation exchange capacities of Ohio Soils are given below in milliequivalents per 100 grams of soil (meq/100 g soil).

Soil Textural Groups	CEC meq/100 g soil
coarse	5-15
medium	10-30
fine	25-30
organic soils	greater than 50

Organic Matter (OM): Mineral soils with greater division than 5 percent OM content are better suited to application of sludges high in heavy metals because OM increases the CEC of the soil and also immobilizes some heavy metals.

Phosphorus Retention: Sludges contain large amounts of phosphorus, all of which will become available with time. High rates of sludge application should not be made on sandy or organic soils because these soils have a low phosphate retention capacity and large sludge applications could result in downward movement of phosphate into groundwater.

Physical:

Texture: Texture is probably the most important physical characteristic of soils because it affects many of the other soil physical properties. In general, the limitations on sludge application by texture include:

Sands, loamy sands: Leaching of nitrates and other soluble sludge components is the major hazard; sands also have low phosphate retention capacity, low CEC and low buffer capacity (does not resist changes in pH).

Loams, sandy loams: These soils have few limitations to sludge application.

Silt loams: Major limitations include soil crusting and erodibility.

Clays, silty clays, clay loams, silty clay loams: Major limitations are poor drainage, poor aeration, and slow permeability.

Structure: Soils with massive subsurface structure restrict water movement, resulting in impaired drainage and poor aeration. The use of sewage sludge on soils with such subsurface horizons (for example, fragipans) should be avoided.

Soil Erodibility: The susceptibility of a soil to erosion depends on many factors, the most important of which are slope, soil texture, and vegetative cover. The greatest hazard is on fine textured soils. Sludge application on sloping (greater than 2 percent), fine-tex-

Continued next page

tured soils should be avoided unless vegetative cover is maintained on these soils to increase infiltration.

Unincorporated sludge on bare slopes greater than 6 percent will move during runoff. Erosion control should meet the recommendations in the Ohio Erosion Control and Sediment Pollution Abatement Guide, Cooperative Extension Service Bulletin 594.

Soil Permeability: The rate at which water moves through soil is important in sludge application. Soils with either very high or very low permeability should be avoided. Highly permeable soils are susceptible to leaching, and sludge may contaminate the groundwater. Those with low permeability have internal drainage problems which restrict sludge decomposition.

Drainage: Successful decomposition of sludge in soil requires good aeration and therefore soils with poor internal drainage should be avoided for sludge application. Fine-textured and poorly-drained soils, and soils in depressions should be properly drained before they are used for sludge application.

Most sludges are high in soluble salts, and although this should not be a major problem in high rainfall areas like Ohio, salt accumulation could be a problem in depressional areas.

Summary of Site Restrictions for Sludge Application by Soil Textural Class

Soil Textural Class	Textural Class	Physical	Chemical
Coarse	Sands Loamy sands Sandy loams	Wind erosion, deep leaching	Low P retention, low pH buffer capacity, low CEC
Medium	Loams Silt loams	Dense subsurface horizons including fragipans, crusting	
Fine	Clays Clay loams Silty clay loams	Poor drainage, poor aeration, slow permeability, rapid runoff on sloping areas, erodibility	Salt accumulation

Handling and Application

The principal factor in determining proper application techniques is the physical characteristics of the sludge. Will it be handled as a liquid, semisolid, or solid? It is assumed that the sludge to be applied to land is digested or stabilized. In the digestion process, the total solids content normally ranges from 3 to 5 percent, i.e., 97 to 95 percent water. The solids content can be increased by various processes at the treatment plant, such as thickening, dewatering, or drying. The decision as to equipment for transporting the sludge, applying it to the land, and/or incorporating it into the soil will dictate the solids content that can be used, or vice versa.

Other factors affecting the method of transport and application are: quantity of sludge produced (size of the city), land considerations (topography, vegetative cover, soil type, acreage available), and time of application (weather, soil trafficability, cropping).

Environmental concerns affecting the method of applying sludge to cropland are: control of surface and groundwater contamination, odor, and aerosol (mist) control. Methods of storage, handling, timing, and rate of application and type of land used, can be managed to minimize these environmental problems.

This section considers application of sludge in the "liquid" form using spray irrigation, overland flow irrigation, tank truck/wagons and immediate soil incorporation. Also, handling sludge cake in the "solid" form using truck spreaders will be discussed. Irrigation equipment will be used primarily by a large city, since the capital costs for equipment capable of pumping, transporting and applying sludge is too great for small cities. Small municipalities will most likely use tank trucks which allow flexibility in selecting application sites and time of application. Immediate soil incorporation can be used with irrigation equipment or tank trucks. Capital costs for dewatering equipment are high so that only larger cities likely will be concerned with applying sludge cake in the "solid" form, with the one exception of cities that use sand filter/drying beds.

Sprinkler Irrigation: Where sprinkler irrigation is selected, a solid-set system is recommended over a portable pipe system for operating and management reasons. Self-propelled systems, such as center pivot and traveling gun, are also feasible. With the traveling gun system, a large single sprinkler on a carriage is winched across the field, pulling a flexible hose through which the sludge is pumped. Figure 1 shows a traveling gun flexible hose system.

Overland Flow: Liquid sludge is discharged at the top of the slope and allowed to flow down. The solids content of the sludge and the slope steepness determine what length of slope is usable. Generally, use of 1 to 2 percent slopes gives good control. This method can be used on wooded as well as grass-covered slopes. A variation of this method, ridge and furrow irrigation, can be used with row crops.

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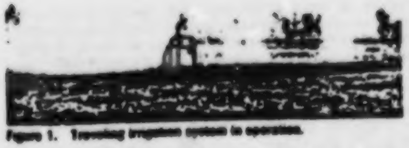

Figure 1. Traveling irrigation system in operation.

Tank Truck: Commercial tank trucks and tank wagons are available. Those with high flotation tires for traversing soft ground may have a restricted hauling range. Regular trucks can be used on grass covered or dry fields. Attachments for tank trucks to allow for field spreading are very simple, involving a quick opening closing valve and a deflector plate to fan the slurry over a wider area. In most cases, gravity discharge is used, but some commercial tanks can be pressurized or pumped. Figure 2 shows a tank truck with gravity discharge. The tank truck can be elevated to give more uniform discharge and remove solids. Figure 3 shows a truck with a pumped discharge which can be directed to the side. This truck can be driven on a road or improved lane during soft ground conditions and spray the waste on the field. Local and state regulations should be checked before discharging sludge from public roads. The use of a pressurized tank or pump discharge should be considered if only one unit is to be used and regular field application is required

Figure 2 Gravity discharge of sludge with capability of elevating tank.

Figure 3 Commercial tank truck with pumped discharge. Photo courtesy of Gorman-Rupp Co., Mansfield, Ohio

Immediate Soil Incorporation: In situations requiring runoff and odor nuisance control, immediate incorporation of sludge into the soil is desirable. This can be done with several types of commercial equipment: chisel injectors on tank wagons, plow furrow cover equipment on tank trucks, surface spreading followed by plowing, and flexible hose attachments to moldboard or disc plows. The first two types are utilized for smaller quantities of sludge. The latter two types are more suitable for large scale operations. Figure 4 shows a tank wagon injecting liquid waste into the soil.

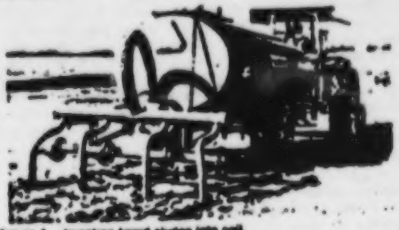

Figure 4. Injecting liquid sludge into soil.

Truck Spreaders: The process of dewatering sludge permits hauling less water to fields. When 5 percent sludge is dewatered to 25 percent, approximately 80 percent of the water is removed. The conventional box spreader has been used for many years to field-spread animal manure. Adaptation of the manure spreader to a truck mounted spreader, as shown in Figure 5, can be used for spreading semi-solid or solid sludges. Truck attachments have been developed for direct incorporation of semi-solid or solid sludge into soil using a moldboard or disc plow.

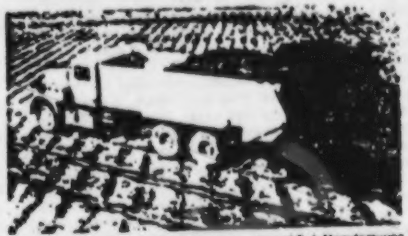

Figure 5 Truck box spreader. Photo courtesy of B J Manufacturing Co., Dodge City, Kansas

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Crop Management

Sludge contains plant nutrients (See Characteristics of Sludge), and when used by the grower with proper management, it is a valuable supplement to chemical fertilizer. Sludge also can contain varying amounts of metals which can be toxic in the food chain when concentrations are high. Therefore, the quantity of sludge which can be applied safely on soil must take into account the amount of heavy metals applied as well as the nutrient requirements of the crop. When the heavy metal content is high, the sludge application rate will be determined by the amounts of these metals that can be tolerated safely. With "clean" sludges (those low in heavy metals), the application rate will be determined by the nitrogen requirement of the crop, since excess applications of nitrogen can result in contamination of ground and surface waters. Other criteria which should be considered with respect to land application of sludge are pathogens, site characteristics, monitoring, and economic considerations. The last three are covered in other sections.

Pathogens: Some pathogens will reach the soil and vegetation during recycling of sludges. However, due to a relatively rapid mortality of pathogens in the soil, the presence of these organisms should not be a large factor in limiting the applicability of land application of sludge wastes. Root crops or crops eaten raw should not be grown in the year of sludge application.

Excess Trace Elements Including "Heavy Metals": Although sewage sludge contains all nutrient elements essential for the growth of higher plants, it also contains, depending on the source, other elements which might be harmful to crops and to the food chain if applied to soils in excessive amounts. These elements are: Zinc (Zn), Copper (Cu), Nickel (Ni), Cadmium (Cd), Chromium (Cr), Mercury (Hg), Lead (Pb), Boron (B), Molybdenum (Mo), Cobalt (Co), and Selenium (Se).

The trace elements zinc, copper, and nickel are definitely toxic to plants when they occur in soil in significant amounts. In general, copper is considered two times and nickel four times as toxic as zinc to plants. Cadmium in high concentration in soil is toxic to plants, but normally cadmium contents of most sludges are not high enough to cause plant injury. Chromium present in sludge applied to soil is converted to a form that is not taken up by or harmful to plants. Lead can be toxic to plants in acid soils which are also low in phosphate. However, lead in the sludge appears to be non-toxic since the large amount of phosphate in sludge ties up the lead and prevents injury to plants. Boron at the levels present in sludge is not harmful to plants, except perhaps in soils normally high in boron. The concentrations of molybdenum, selenium, and cobalt in domestic sludges are so low that in order to reach maximum concentrations in the normal range of natural soils, the application of unrealistically high quantities of sludge would be required.

Trace elements found in sewage sludge, with the exception of cadmium, copper, and zinc, constitute no hazard to the food chain through plant accumulation. However, surface contamination of vegetation by recently applied sludge containing trace elements and subsequent direct ingestion of metals will be a special hazard to grazing animals. Cobalt, nickel and boron at levels that markedly injure plants present no threat in the food chain. Although mercury from the sludge will increase soil mercury levels, the increase in plants will be very small, thus constituting little hazard. Excess zinc is toxic to animals if the diet contains between 500 to 1,000 ppm (parts per million) zinc. Since plant yields are usually significantly reduced at zinc levels less than 500 ppm, the food chain, seemingly, is not jeopardized. Plants exposed to excessive levels of copper will be injured before they can accumulate enough copper to be toxic to most animals. However, sheep are very sensitive to copper. Toxicity results when sheep diets contain 12-15 ppm copper. The potential hazard of cadmium in the food chain is of major concern. Application of sewage sludge containing cadmium increases soil cadmium which in turn can lead to increased food chain cadmium. The suggested acceptable level of cadmium in sewage sludge for land application is less than 1 percent of the zinc content of the sludge.

Factors affecting the accumulation of sludge-borne heavy metals by crops are: pH, cation exchange capacity, organic matter, phosphorus, and crop species. In general, the availability of heavy metals in the soil decreases as the soil pH is increased. There is little uptake of heavy metals by plants when soil pH is neutral. Soils with a higher cation exchange capacity have greater retaining power for heavy metals; this, in turn, reduces the amount of heavy metals available to plants. Soil organic matter plays an important role in retaining heavy metals through its high cation exchange capacity and chelating ability. Phosphates reduce the stunting injury to plants from high levels of copper, zinc, and nickel. Plant species and varieties vary in their abilities to accumulate heavy metals. Based on current knowledge of relative crop tolerances to heavy metals, some vegetable crops, e.g., beets, kale, mustard, turnips, and tomatoes, are reported to be very sensitive while others such as beans, cabbage, and collards are considered to be sensitive. Field crops such as corn, soybeans, and small grains are moderately tolerant and most grasses (e.g., fescue, lovegrass, bermudagrass, and perennial ryegrass) are classified as tolerant. The concentrations of heavy metals in the vegetative tissues of plants are much higher than in fruits and seeds.

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According to the U.S. Environmental Protection Agency's proposed guidelines (Acceptable Methods for the Utilization or Disposal of Sludges), application of digested sludge with zinc equivalents up to 10 percent of cation exchange capacity is permissable on agricultural land with the pH of 6.5 or greater.

Based on the above proposal, no greater total amount of digested sludge may ever be applied than that calculated by Equation 1 for the sludge and soil in question.

Equation 1:

Total amount of sludge (dry tons/acre) =

$$\frac{\text{CEC} \times 32{,}700}{\text{ppm Zn} + 2(\text{ppm Cu}) + 4(\text{ppm Ni}) - 200}$$

CEC = cation exchange capacity of soil before sludge application (meq/100 g)

ppm = parts per million or mg metal/kg dry weight of sludge

Equation denominator = Zn equivalents indicating that Cu is two times and Ni four times as toxic as Zn to plants.

In addition, the U.S. Environmental Protection Agency recommends that sludge not be applied to cropland if the cadmium content is higher than 1 percent of the zinc content.

Equation 1 should be used as a guideline for slightly acid to neutral soils where soil pH can be maintained at 6.5 or higher at all times. However, in those regions where soil pH is not maintained at 6.5 or more, total digested sludge that may ever be applied is calculated by Equation 2 which would permit sludge application with a zinc equivalent of 5 percent of the cation exchange capacity.

Equation 2:

Total amount of sludge (dry tons/acre) =

$$\frac{\text{CEC} \times 16{,}350}{\text{ppm Zn} + 2(\text{ppm Cu}) + 4(\text{ppm Ni}) - 200}$$

For forest soils below pH 6.5, the amount of sludge that can be applied is reduced to a zinc equivalent of 2.5 percent of the soil CEC as given in Equation 3.

Equation 3:

Total amount of sludge (dry tons/acre) =

$$\frac{\text{CEC} \times 8{,}175}{\text{ppm Zn} + 2(\text{ppm Cu}) + 4(\text{ppm Ni}) - 200}$$

The total amount of sludge (calculated from Equation 1, 2, or 3) can be applied as a single application or spread over a period of time. The nitrogen needs of the crop and nitrogen content of the sludge should also be considered in determining how much to apply at any one time.

When sewage sludge is to be applied on pastures, concentrations of lead and cadmium in the sludge must be below 1,000 and 22 ppm, respectively, and the cadmium content of the sludge should not exceed 1 percent of the zinc. Grazing animals should not be permitted on pastures while crops are physically contaminated by sludge. Thorough removal of sludge from vegetation by rain is required in order to reduce the risk of direct ingestion of the sludge by grazing animals.

Nutrient Requirements: On the average, a ton of dry sludge contains approximately 100, 50, and 10 pounds of nitrogen, phosphorus, and potassium respectively. Application of digested sewage sludge at the rate of 5 tons (dry basis) per acre would furnish about 500 pounds of total nitrogen, 250 pounds of phosphorus, and 50 pounds of potassium. Only about 30 percent of the total nitrogen would be available to crops immediately, and therefore the "crop-available nitrogen" from five tons per acre application of digested sewage sludge would be about 150 pounds of nitrogen per acre. About 5 to 6 percent of remaining nitrogen mineralizes each year. The phosphorus in the digested sludge is readily available for plant uptake. Since digested sludge is not a good source of potassium for crop production, supplemental potassium fertilizer would be required for low K soils. In order to establish a sludge application rate, the following data are required: 1) total and inorganic nitrogen content of sewage sludge; 2) nitrogen, phosphorus, and potassium needs of crop to be grown; and 3) a soil test for available phosphorus and potassium. Although ammonia compounds in the sludge adversely affect the germination of some seeds, a normal germination can be attained if seeding is done at least 1 to 2 weeks after sludge application.

Also noted should be the loss of ammonia nitrogen if sludge is not incorporated into the soil soon after application.

Since sludge is not a balanced fertilizer, applications over time may result in an imbalance of nutrients. Soil and plant analyses must be used to monitor the levels of available nutrients in the soil (See Testing Section) and supplemental fertilizer should be applied to balance the nutrient supply required by the crop.

Sludge on Crops: Sewage sludge, because of its nature, should not be applied to certain crops such as root crops and leafy vegetables. Sludge should not be applied to pasture crops unless animals are removed from the pasture until the sludge has been washed off the leaves. It should be noted again that there is a greater risk of contamination with foliage crops, including vegetables, forages, and silage, than with grain and fruit crops because contaminants do not accumulate in fruit and grain to the same extent as in leaves.

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Sludge can be applied on forest crops, but the same restrictions apply to forest as to food crops in order to preserve the wildlife and water resources associated with woodlands. Nitrogen leaching to groundwater in undisturbed forest soil is a major hazard with sludge application. Undisturbed forest soils contain large pores that transport water rapidly. These pores, earthworm and insect tunnels, small mammal burrows, and old root channels may extend downward for several feet, and laterally for tens of feet. In sandy soils, root channels fill up with sand; but in finer textured soils, the channels persist like drain tile. Clay skins and root bark prevent water movement from the pores into adjacent soil.

Infiltration from sewage sludge applications will move rapidly through these large pores without wetting the soil mass, so there is a potential for both groundwater contamination by rapid vertical movement and for stream pollution by rapid lateral flow down slopes. Lateral flow could be interrupted by thoroughly disturbing a strip of soil between the sludge application area and the watercourse. Protecting the groundwater will be more difficult. Forested areas where groundwater is an important resource should not be used for sludge application. Problems associated with rapid vertical and lateral water movement in channels will be less serious on coarse textured soils such as sandy loams and silt loams, and more serious on silty clay loams, clay loams, and clay soils.

Dried sludge can be used on lawns and ornamental species as long as direct human contact with the material is avoided. Heavy metal and nitrogen limitations also apply to these crops, and it should be noted that some ornamental crops are probably sensitive to heavy metals.

Time of Application: It is best to apply sludge when it can most efficiently be utilized by the crop and, if possible, sludge should be incorporated into the soil to reduce odors and runoff problems. Sludge should not be applied on snow-covered, frozen, sloping land unless there is adequate plant cover or residue to retard runoff. It should not be applied to poorly-drained soil when the water table is near the surface. In general, it is best to apply and incorporate sludge several weeks before planting. Sludge can be applied to established forage stands at most times of the year as long as adequate time is given for the sludge to wash into the soil before the forage is cut or animals are allowed to graze. Trees are perennial crops and must survive cold winters in many areas of the country. Application of sewage sludge in late summer or early fall could prevent development of cold hardiness by stimulating a new flush of rapid twig growth. Therefore, sludge should not be applied to forest land in late summer or early fall, but in spring and early summer, up to around July 15.

Economic Considerations

Substituting Sludge for Commercial Fertilizer: Valuing sludge as a substitute for commercial fertilizer is complicated by its variable chemical composition and by fluctuating fertilizer prices.

Table 4 presents three price levels for fertilizer to be used in arriving at the nutrient value of sludge.

Table 4: Assumed Prices for Fertilizer Nutrients

	Price Range (Dollars/Pound)		
Nutrient	High	Medium	Low
N (Nitrogen)	.40	.30	.20
P_2O_5 (Phosphate)	.25	.20	.15
K_2O (Potash)	.14	.11	.08

Table 5 demonstrates the range in the fertilizer replacement value of sludge which Ohio municipalities might provide using the price levels shown in Table 4.

Table 5. Value of Nutrients in One Ton of Dry Sewage Sludge Under Nine Alternative Assumptions for Nutrient Content and Commercial Fertilizer Price*

	Value of Nutrients in Sludge		
Nutrient Content	High**	Medium**	Low**
Low (N-3.5%, P_2O_5-1.8%, K_2O-0.20%)	$18.91	$14.66	$10.40
Medium (N-4.95%, P_2O_5-5.25%, K_2O-0.54%)	40.83	31.98	23.14
High (N-6.4%, P_2O_5-8.7%, K_2O-0.84%)	62.75	49.30	35.88

*[illegible]

**[illegible]

Table 5 demonstrates that the value of sludge varies tremendously as a fertilizer replacement. The value may vary from $10.40 per ton to approximately $63.00 per ton. Thus, landowners will need to carefully determine the current sludge content and nutrient value in making a decision relative to having sludge applied to their land.

Testing

Routine tests should be made on sludge before the material is used. Several of these determinations are the same as those used in routine soil analyses. Organic matter, pH, and soluble salts content (electrical conductivity) tests of the sludge should be made. Sludges from different municipalities vary considerably in their moisture content and, therefore, total solids (dry matter) determinations must be made before any recom-

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mendations can be given regarding the amount of material to apply.

The nutrient element content of sludge must be measured to help determine if additional fertilizer should be added to balance the amount of nutrients supplied. Types and quantities of metals in sludge vary considerably from one municipality to another, and even at a given facility depending on when the sludge is sampled. Metals would be expected in greatest amounts in sludge from municipalities which service certain kinds of industries. Conversely, these metals will probably be less significant in sludge from primarily residential areas. However, determinations of the metal content should be made regardless of source. All test results should be made available to the grower well in advance of land application to allow enough time to determine application rates.

Standard soil tests should be made prior to sludge application so growers can determine the total amounts of nutrients that will be available from both sludge and soil. Samples for this test should represent no more than 20 acres. These tests consist of pH, cation exchange capacity, lime test index, available phosphorus, exchangeable potassium, calcium and magnesium. Additional tests should be made for available zinc, boron, and possibly molybdenum. Waterways adjacent to the anticipated application area and nearby springs and wells should be tested to determine background levels of nitrate-nitrogen and coliform bacteria.

Monitoring Schedule After Application

The soil tests mentioned above should be made each year prior to fertilizer applications. Some constituents of sludge will remain in the soil for many years while others will disappear rather rapidly. If any nutrient imbalance in the crop is suspected, plant analyses should be used to help diagnose potential nutritional problems, either toxicities or deficiencies. Heavy metal analyses of consumable plant parts from sludge-amended soils is desirable, especially when amounts applied approach or exceed recommendations given in this publication. Water sources originating near the sludge application area and eventually discharging into larger streams should be periodically sampled and tested for the presence of trace elements and nitrates.

It is important to point out that in addition to heavy metals, sewage sludge may contain some persistent compounds which may be harmful to crops. Since these compounds cannot be identified easily, simple seed germination tests in both uncontaminated soil and soil mixed with sewage sludge are desirable.

Procedure for Collecting, Handling, and Submitting Sludge for Analysis

When submitting a sample for analysis, the name of the municipal sewage treatment plant should be provided so that sludge from different localities can be characterized, to help develop sound recommendations for the grower who uses sludge as a fertilizer. Tests of sludge samples can be conducted by several laboratories located around the country. County Extension offices are being provided the addresses of known facilities. Furthermore, some of the larger municipalities either have or are obtaining the capability to analyze sludge.

Sludge should be collected in water-tight, air-tight plastic containers of approximately one pint size, depending on the estimated water content.

The table below indicates the sample size to be collected relative to the estimated water content.

Water Content	Solids	Volume to Collect or	Weight to Collect
98%	2%	1 gallon	8 lbs.
95	5	1 1/2 quarts	3.2 lbs.
90	10	1 1/2 pints	1.6 lbs.
80	20	1 pint	0.8 lbs.
70	30	1/2 pint	0.5 lbs.

Social Concerns

The concept of land application of sludge for crop production has been used for centuries in the Asiatic and European countries. They consider sludge as a valuable natural resource which can replace fertilizers and increase crop yields.

A key consideration in determining the practicability of land application of sludge is whether landowners, farmers and other persons in the community do in fact see an advantage to receiving this material and view the material as not being a problem from the standpoint of either economic, health or nuisance considerations. Past experiences have clearly demonstrated the need for landowners and other affected citizens to be involved in the decision-making process at the earliest possible time. It is essential to determine what economic benefits are expected to accrue to the person who received the material as well as to demonstrate what long and short term effects the application of sludge will have upon the land. Landowners are interested in knowing the characteristics of the material under consideration, i.e., the extent of heavy metals, the nature of the product such as whether it is to be five percent solids or thirty percent solids, and how much moisture this means would be applied to the land. They also must be given information about alternative methods available for application, crop management practices, and monitoring safeguards that can be taken to ensure that protection is provided against any detrimental effects.

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The following considerations with regard to an educational program are recommended:

Educational materials must be developed which:

—clearly and concisely state current status of sludge disposal in the community involved and indicate the likely future possible sequence of events.

—depict what information is of a specific nature and which can be generalized

—clearly outline the practical alternatives involving land application of sludge

—supply a means to permit local landowners and citizens to evaluate these alternatives before final recommendations are made

This will require a simplified analysis of the pros and cons of each alternative. This information should include not only the technical aspects but the social, economic and political aspects as well.

Those involved in an educational program should not try to "sell" any one proposed alternative. (Every effort must be made to provide local citizens opportunities to make choices). Any educational effort should let it be known early that its main function is to disseminate information and provide an objective forum for discussion of the various alternatives in dealing with the whole question of sludge disposal.

An opportunity should be provided for interested persons to visit sites where sludge has been applied to the land. In addition, where possible, it would be desirable to establish demonstrations at several farms located in the area under consideration.

An educational or information program should accompany the establishment of such demonstrations. A program should be one where:

—the problem is clearly identified

—factual information regarding alternative solutions is presented

—a forum is provided for input by all interested

—it is recognized that in the final analysis the decision of which alternative is implemented is made by the people

Effort must be made to make certain that all possible factual information relating to the demonstration is presented.

Relationship Among Agencies

The authority of the Ohio Environmental Protection Agency to regulate land application of sewage sludge is derived from both state and federal laws. Sections 6111.44 and 6111.45 of the Ohio Revised Code require that plans for all sewage and industrial waste treatment systems be submitted to OEPA for approval and that such approval be based on whether or not the proposed system will pollute the state's waters or present a hazard to the public's health. The National Environmental Policy Act (NEPA) of the U.S. Congress also requires that an environmental assessment be prepared for any proposal which would receive federal funds. In practice, this means that plans and, if appropriate, an environmental assessment should be submitted to the OEPA. The OEPA engineers and planners would then verify that the proposal is based on sound engineering judgment and that it would not cause significant water pollution or present a threat to the public's health. If federal funds are involved, OEPA would also verify the cost effectiveness of the proposal and consider the overall environmental impact of the proposal.

It is important for landowners to understand that an approved plan for sludge application does not remove their responsibility for water pollution or health hazards that result from the application of this sludge on their land. Plan approval means that in the judgment of OEPA the proposed system should function satisfactorily. However, it is possible that unforeseen problems might arise. In such situations the OEPA would give the landowner a reasonable period of time to rectify the problem. Of course, the landowner should also reserve the option to discontinue sludge application on farmland in the event of such unforeseen problems.

The local health department would become involved only if a nuisance or health hazard situation were to exist. It is recommended that landowners contact the local health department for guidance and support prior to applying sludge to their land.

[illegible]

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Roy M. Kottman, director of the Cooperative Extension Service, The Ohio State University

Letter #42

Route 1 Box 198
Keenesburg, CO 80643
September 3, 1976

Gentleman:

I regret that I could not present this in person, but I would like to make my opinion known, and share what knowledge I have of sludge with you.

As a junior majoring in agronomy at Colorado State University, I had an opportunity to work with several graduate students and professors on the subject of sludge composition and effects on the land when it was spread.

Some of the problems inherent with sludge are:

① 1. Sludge, as is true with manure, sometimes causes crops to fail because of germination inhibition.

② 2. Sludge sometimes causes severe stunting or necrosis in certain crops at a particular stage of growth,

③ 3. Under certain conditions which prevail in the area where the sludge dispersal is planned, Nitrate-Nitrogen leaching is severe. Applying sludge on winter wheat lands in the fall would many times be a complete waste of time, as all the Nitrogen would have been released in the Nitrate form, which readily leaches.

④ 4. Sludge is high in toxic heavy metals. Although the analysis usually shows only a few parts per million (ppm), it should be noted that small quantities can be toxic. For example, for most crops zinc is toxic for plant growth at levels of 1 ppm and iron at 4 ppm, and sludge has much greater concentrations than this. Other metals frequently found in sludge are copper, cadium, lead, manganese, and nickel, among others. Some root crops cannot be grown because of the metals.

⑤ 5. Sludge has the inescapable problem of the pathogens which cannot economically be eliminated and which pose a threat to the public safety.

⑥ 6. Another problem relating to sludge and soil fertility is the problem of residual phosphorus in the upper six inches of soil.

Continued next page

EPA Response

① Inhibition of germination is generally related to the unavailability of nitrogen, which may be consumed during active biological decomposition processes in manure, sludge, or any rotting organic matter. The Metro product will have been anaerobically digested and dried for almost a year's time. There should be relatively little germination inhibition with sludge applied under these conditions (Reference 45). Metro will have the opportunity to evaluate the timing of sludge application in their research and demonstration areas, if this project is built. We do feel that if a rational approach that includes a consideration of timing of application and crop growth is followed, the beneficial aspects of sludge can be achieved.

② As the writer states, this problem can occur with certain crops under certain conditions. However, with proper management procedures, this problem should not occur with any of the proposed uses of Denver sludge. In general, if the management procedures currently followed for animal manures are followed with sludge application, no stunting or other adverse effects to crops will occur. (Reference 4).

③ The beneficial aspect of applying sludge as fertilizer is that much of the nitrogen is in the organic form that is only slowly released. Therefore a winter wheat application of sludge in the fall could be a valuable exercise. Certain areas that have a nitrate leaching problem, often from overapplication of commercial fertilizers, would indeed be a bad choice for sludge application. On the other hand, fertilizer applications should also be restricted to correct the problem.

④ Heavy metal chemistry in the soil is an extremely complex issue. Some heavy metals at micronutrient concentrations (Cu, Mn) are toxic at higher concentrations. The presence of metals in the soil is no guarantee of their availability. Likewise, applications of certain concentrations of heavy metals is not always reflected in plant uptake. Each plant species also has differing sensitivities to various metals, as well as differing uptake rates. For these reasons, experts and researchers in the field of sludge application studies are not able to agree on firm values for heavy metal limits. There is much research to demonstrate the general effectiveness of sludge as beneficial to most growing crops, however. A recent summary appraising the potential hazards of heavy metals to plant and animals was published by the Council for Agricultural Science and Technology entitled; Application of Sewage Sludge to Cropland, Report No. 64, November 15, 1976. Their summaries on the effects of application of zinc and iron are as follows:

Fe:

"The levels of iron... in sludge usually will not be of any environmental concern. Even though many tertiary sludges may be high in iron.. (it) will not be a limiting factor in determining the quantity of sludge that may be applied to agronomic crops if the soil pH is maintained above pH 5.5 and the soil.. is well aerated." (p.25)

Zn:

"In general, if the pH value of sludge-treated soils is maintained at the recommended level, zinc should not be serious hazard to plants or to the food supply unless exceptionally high levels are added in the sludge. In many instances, a moderate increase in the zinc content of the food supply should be beneficial because there is evidence that diets are often deficient in zinc." (p. 36)

The apparent key to minimizing the negative effects of heavy metals is by control of pH at or above 7. Most Western soils are alkaline and meet this criterion. The sensitive crops are generally the ones least likely to have sludge applied, such as edible root crops or vegetables. The crops constituting the bulk of Colorado production— corn, wheat, grasses, and perhaps even sugar beets— could make safe use of the sludge.

Letter #42, continued

September 3, 1976
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⑥ The labile phosphorus and available phosphorus do not leach but accumulate in the soil if not used and can become toxic under certain conditions.

⑦ 7. An evident problem associated with sludge is ODOR. The application of sludge on land will result in considerable offense to the residents and landowners of land in an area much greater than the site of application.

⑧ At present, the Denver Metropolitan area produces on the average about 100 tons of sludge a day, or 36,500 tons a year. The average analysis shows sludge is 5 percent nitrogen. If this nitrogen was applied at 200 pounds nitrogen per acre (which is even a high rate for irrigated crops--dryland use would be 30-50 pounds per acre), it would fertilize 18,250 acres per year, or 28.5 sections. Sludge application on a year after year basis would ruin the soil for crop production. Therefore, I think there would be a great problem with oversupply and almost no demand for the sludge.

On the basis of these reasons, I strongly urge the Environmental Protection Agency to deny the Denver Sewage District the permission to build this planned facility. Sludge as a fertilizer has many problems and could ruin production of the land. With an ever-increasing population, we cannot afford to take a chance to hurt productivity.

Respectfully yours,

John J. Sauter

JJS:kls

EPA Response

⑤ Again, the threat to public safety is a relative one. EPA feels that sludge applications on home gardens, particularly edible root crops and leafy vegetables, are the least desirable form of sludge application. Applications on individual irrigation or sod farms allows a greater degree of monitoring of possible pathogen effects, and minimizes the risk of transmission of any pathogens.

⑥ This statement is true. However, the high calcium content and high pH of the area soils will render excess phosphorus insoluble, and largely mitigate this problem. Over a long period of sludge application phosphorus could build up to harmful levels. However, it is likely that buildup of other materials, such as metals or salts, will limit sludge application long before phosphorus reaches unacceptable levels.

⑦ There will be some odors from the drying/distribution site, although it is not expected to be generally noticeable any distance from the site. Odor problems are not expected on individual application sites (see letter from William Sharp, Letter # 4). Also see discussion on odors, Issue II-3.

⑧ Because of the drying procedure, the total nitrogen content of the dried sludge will be between 2 and 5%. We agree that if all the sludge was dryland spread, your estimate of the number of acres needed is valid. However, where more intensive applications of fertilizer are called for (e.g. irrigated or sod farms), the nitrogen requirements might be increased by one to three orders of magnitude. The EIS concludes on page 104 (Volume I) that if all sludge were applied to irrigated farms, about 2800 ha [7000 acres] of land would be needed. There could be an oversupply of sludge in certain times; under these circumstances, the dried sludge could be stored or buried in the Lowry Landfill at relatively low cost.

Letter #43

My name is Vincent Sauter. I'm a journalism major at the University of Colorado, and I've been a resident of rural Adams County for 23 years. My father farms approximately seven miles northeast of the proposed dumping site. Therein lies my initial interest.

But on the other hand I see an issue that has, and I think will remain an emotional one. The opportunity to speak ones mind at a public hearing such as this is the only way problems, in a democratic fashion, can be solved. I welcome this opportunity to speak, because I see the need of the opposition to the proposal, in this case a minority, to have their right to an airing of some very concerned opinions. In so many issues, such as this one, where approval or disapproval of something rests on the shoulders of a few, I think it imperative that we give those people who will ultimately make the ruling, something they can base that ruling on.

I'm very concerned that the people who are opposed to Metros dumping of sludge in rural Adams County won't speak up the way they should. I'm concerned because I sense a feeling of frustration in these people, a feeling of frustration growing out of the fact that they feel over-powered and over-shadowed by a very large government entity which can drastically influence their lives.

But these people shouldn't feel afraid to speak their minds and hearts. They have a very large stake to lose, and they should fight for what they believe is right.

For many of the people living near or adjacent to the proposed dumping site, this plan by Metro is an affront to their

Continued next page

Letter #43
continued

dignity and livelihood. Many of them have lived and farmed in that area for 40 or more years-a time in which they have grown to love the purity of the region. No matter how desolate and barren the area may seem to city dwellars, it still serves as home for quite a few who cherish the fresh air and clean

① water. And it is a very productive agricultural area. Anyone can attest to that who has seen the large amount of wheat harvested there.

Some proponents of the plan will say, "great, the application of sludge will improve that productivity", wherein the farmers who have lived and worked in the region will counter that it's a semi-arid region where the annual precipitation isn't great enough to off-set the burning of the crops.

② The proponents will say the sludge can be used with irrigated crops, but they had better warn the applicators about usage on vegetables since it hasn't been proven whether or not sludge can be detrimental to the food chain.

I think that something this important can't be answered vaguely. It needs a yes-no answer; something black and white, not gray.

I don't think the people in the affected area are that concerned with the pros and cons of sludge usage on farm land. Their main fears are ones concerning water and air quality.

This region wouldn't have been settled if there wasn't sufficient, good drinking water.

Continued next page

EPA Response

① EPA is willing to go along with Metro's choice of site for this project because it believes that the project with suitable modifications will be compatible with the present farming operations. Its presence should not be radically different from any agricultural-supportive business such as agricultural equipment or fertiliser-sales ativities.

② Current Metro plans call for sludge use on irrigated farms or by municipal parks. It is true that the immediate area around the site will derive little or no benefit from the operation. There are enough irrigable lands in the general northeast area growing compatible crops that can receive sludge amendments.

Letter #43, continued

The water is relatively pure-tasting compared to drinking water in Denver.

The Impact Statement talks about permeability rates and says it would take several years before the water table could be affected. There's the problem. It's not a question of if, but when. I have been told that the proposed site lies above a closed basin known as the Lost Creek Basin. That means that the aquifer will, once polluted, be unable ③ to cleanse itself, so to speak. That means that the water quality will continually deteriorate, and eventually could be used only to help pump sludge through pipelines. I'd like to point out that the Lost Creek Basin doesn't just lie under a handful of farmers to the north of the site, but it encompasses some 30 miles of area to the north, and the water from the Basin is used by some irrigated farmers.

Air quality is important, everyone realizes that, ④ especially the Environmental Protection Agency. The proponents claim that the sludge in the drying basins will be relatively stable in high winds, and if need be, it could be sprayed down. That is going to increase drastically the time necessary for the sludge to dry. Coupled with the infrequent down-pours in the area, the six months that Metro says it will take the sludge to dry seems a little unrealistic.

⑤ The question of aesthetics arises. Many say that's no problem since farmers are use to barn-yard [redacted] smells, and anyway the sludge won't smell that bad.

Continued next page

EPA Response

③ EPA will not proceed with this project if it does not believe it can adequately protect water quality. From what EPA has seen of geological, soils and groundwater evidence, we believe that positive protection measures can be taken to insure that groundwaters will be protected. See discussions under Issue II-2.

④ Drying times have not been firmly established. There appears to be adequate capacity in the basins to handle the projected 1985 flows. The additional areas set aside for dried sludge storage would add an additional two year storage capacity onsite. Therefore, wetting the sludge periodically will not cause any significant problems. The sludge is capable of reaching 50% dryness or higher. There should be little problem in re-drying the sludge. In order to afford a more positive approach in protecting against windblowing of stockpiled sludge, EPA will recommend to Metro that the sludge be stockpiled in earthen berms, as was originally planned. See discussion on Issue II-5. Again, EPA believes that this problem can be controlled.

⑤ The question of odors from the site (not the application areas, which we do not think will be a problem), is a difficult one to resolve. Our own field trip to San Jose has convinced us that there will be occasional odors, especially from the freshly pumped sludge. How far those odors will carry is problematic at this time. We think that given the distances of most people in the area from the site, odors will not generally be a problem. For those residents nearest the northern and eastern edge of the site, there may be noticeable odor at times. As a last resort, if the odors should prove to be a nuisance to these neighbors, Metro District should consider buying their properties and/or relocating them. EPA does not feel that the problem should extend beyond the two households discussed here. See discussion on odors under Issue II-3.

There is a general problem faced by any new enterprise, whether private or publicly sponsored, that some individuals are bound to be negatively affected by a project. There is no perfect solution to the problem of managing metropolitan Denver wastewater sludge that will not affect someone adversely. EPA feels that its duty is to minimize harm to any individuals potentially adversely affected by such a project, as well as to the natural environment. EPA will develop grant conditions listed in Appendix A of this Volume to minimize these impacts.

Letter #43 continued

I contend that's the very reason Metro wants the site so far from Denver. They don't want people to complain about the smell, and they are stupid enough to believe that silly barnyard stereotype so long associated with farmers. I say to those people that play down the odor and talk about aesthetics that they are quite mistaken, because a rose by any other name still smells like a rose, and that also applies to sludge.

I'd like to close by saying I hope the E.P.A. does take into account not only the economic and environmental applications, but also the sociological problem facing the farmers in the area. In any democratic nation, the government must watch out for the rights of the minority lest big, powerful entities encroach on the individual who is so often overlooked.

Finally, I'd like to point out the very real possibility of future litigation which could make Metro's proposed use of the B-2 site a very costly mistake. Thankyou.

Letter #44

P. O. Box 131
LOST CREEK
Ground Water Management District
Keenesburg, Colorado 80643

9 September 1976

Regional Administrator
U.S. Environmental Protection Agency
Rocky Mountain - Prairie Region VIII
1860 Lincoln Street Suite 900
Denver, Colorado 80203

Re: Metro Denver Sludge Management Plan
Draft EIS May 1976

The directors of Lost Creek Ground Water Management District have filed a Letter, dated 24 Aug. 76, with your office stating our objection to the proposed plan of locating sludge drying basins in the Lost Creek drainage basin. In that letter you are advised that the plan proposed by Denver Metro Sewage District is in direct violation of regulations promulgated by the directors of Lost Creek Ground Water Management District.

① The purpose of this statement is to present in greater detail the reasons for our opposition to the proposed sludge drying plan. As representatives of the people living in the Lost Creek basin, we feel an acute obligation to preservation and maintainence of the water quality in the area.

There are approximately 300,000 acres in the Lost Creek drainage basin - most of it good agricultural land and approximately one fourth of the total irrigated. Approximately 40,000 acre feet of water pumped from the Lost Creek alluvium aquifer is used to irrigate crops on this land.

② We feel there is a serious danger of contaminants such as nitrates, salts, and heavy metals entering this important aquifer from the proposed drying basins. Since this is a closed basin, such stable contaminants would surely build up to unacceptable levels and would have a deleterious effect on foodstuff produced from the land.

These contaminants would also pose a much more immediate and serious threat

Continued next page

EPA Response

① In addition to the materials appended to this letter, EPA has obtained a copy of the Groundwater Resources of the Lost Creek Drainage Basin, prepared by Nelson, Haley, Patterson, and Quirk, Inc, June 1967. Information from this document has been integrated into the discussion on groundwater conditions in the vicinity of site B-2 (Issue II-1). Further, EPA has taken the position that groundwater resources below the site must maintain drinking water standards. To this end, EPA will require Metro to demonstrate a positive impermeable lining (see Issue II-2), as well as to develop both an intensive site monitoring plan and a positive plan to intercept any site-derived groundwaters that could adversely affect the area groundwater. We believe that given the geology of the area and these mitigation measures, that the water resources of the Horse and Lost Creek Basin areas will be protected.

② While nitrates and salts are of paramount concern to EPA, we believe that heavy metals will not be a problem in the groundwaters. Heavy metals are preferentially adsorbed onto exchangeable cation sites on materials such as clay particles. Metro will be required to monitor for these heavy metals in any event in the groundwater. EPA also does not believe that sludge applications onsite or in the immediate vicinity of the site will result in deleterious heavy metal accumulations. EPA will not permit Metro to utilize the site for sludge applications in excess of acceptable agronomic rates.

Letter #44
continued

to the health and welfare of the estimated 1800 residents of the basin. A large percentage of the domestic and livestock wells in the area are

③ developed in the alluvium aquifer. All domestic water for residents of the district -including municipal supplies- must be pumped from these underground sources. There is evidence that there is some intermingling of water from bedrock and alluvium aquifers so there is a real possibility that contaminants will invade all the underground water available to the people in this district. If the pollutants should be introduced into the bedrock (Laramie - Fox Hill) aquifer, an area much larger than the Lost Creek basin will be affected.

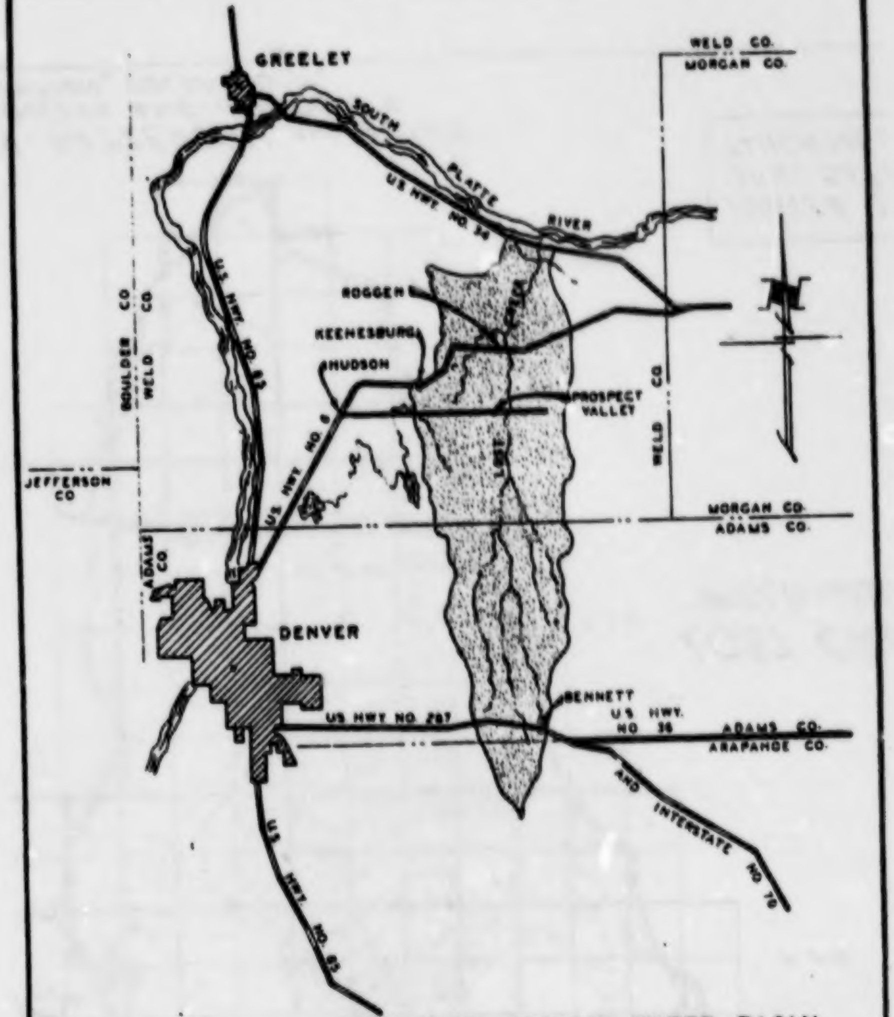
Since water is probably our most important resource we cannot permit deliberate pollution in the district. Our regulations are set up to protect this vital water supply and we believe they are reasonable. We will insist on full compliance with the regulations.

Chris A. Wailes, Pres.
Lost Creek Ground Water
Management District

EPA Response

③ There is a discussion of the potential for contamination of the various subsurface aquifers (alluvium, Denver-Dawson-Arkose, and Fox Hills) under Issues II-1 and II-2. We agree that the alluvial aquifers are the most susceptible to pollution. Although most of the Denver-Dawson-Arkose formations are relatively impermeable, there are occasional aquifers interbedded in this formation as evidenced by area well depths and the presence of a sandstone outcropping on the northwest corner of the B-2 site. The likelihood of an interconnection with the Fox Hills formation is believed to be very slight. Metro will be required to monitor these formation aquifers.

Attachment to
Letter #44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BOULDER CO
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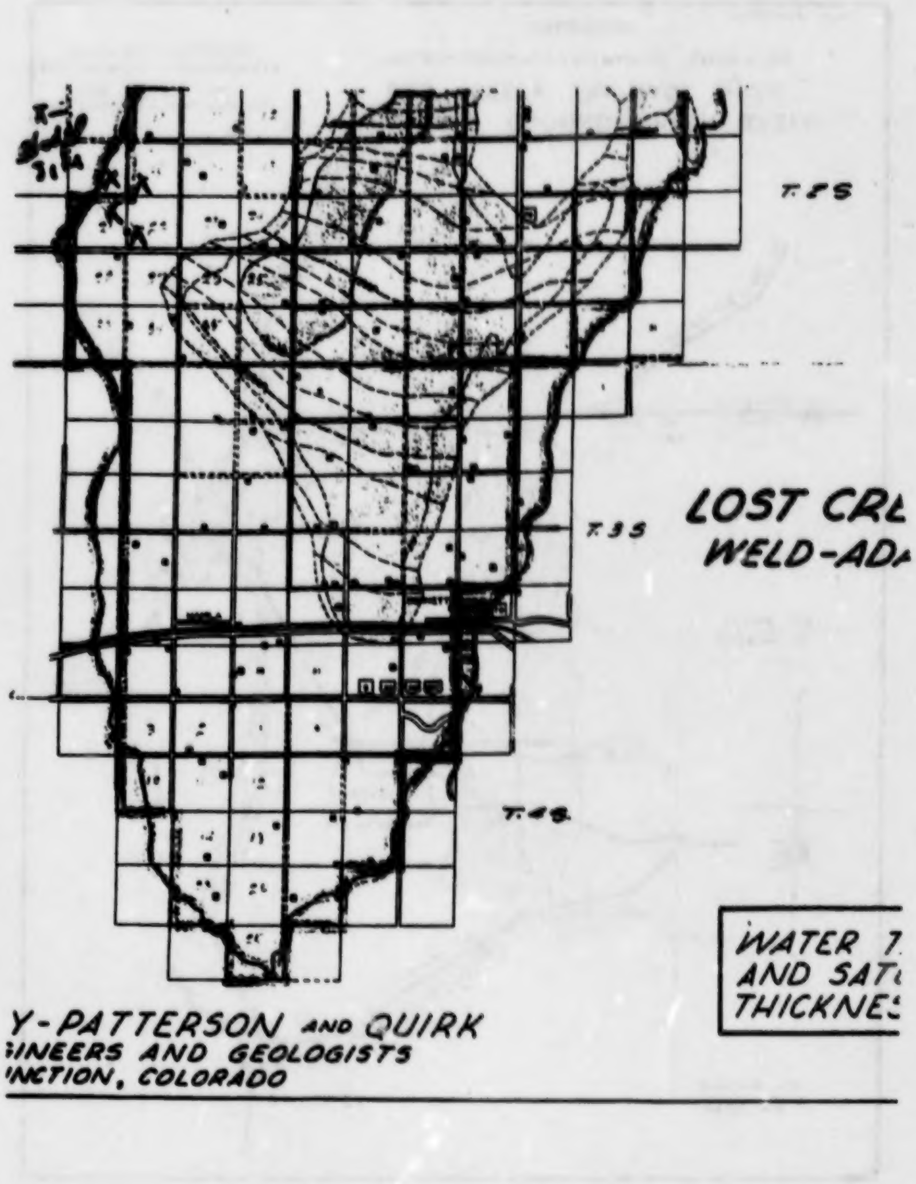
MORGAN CO.
ADAMS CO.
ROGGEN
KEENESBURG
HUDSON
PROSPECT VALLEY
LOST CREEK
US HWY NO 6
DENVER
US HWY NO 287
BENNETT
U.S. HWY. NO 36
ADAMS CO.
ARAPAHOE CO.
AND INTERSTATE NO 70
U.S. HWY. NO. 85

PROPOSED GROUND WATER BASIN
LOST CREEK DRAINAGE AREA
WELD – ADAMS – ARAPAHOE COUNTIES
COLORADO

NELSON-HALEY-PATTERSON
AND QUIRK, INC.
ENGINEERING CONSULTANTS
GREELEY, COLORADO

Figure 1

Attachment to
Letter #44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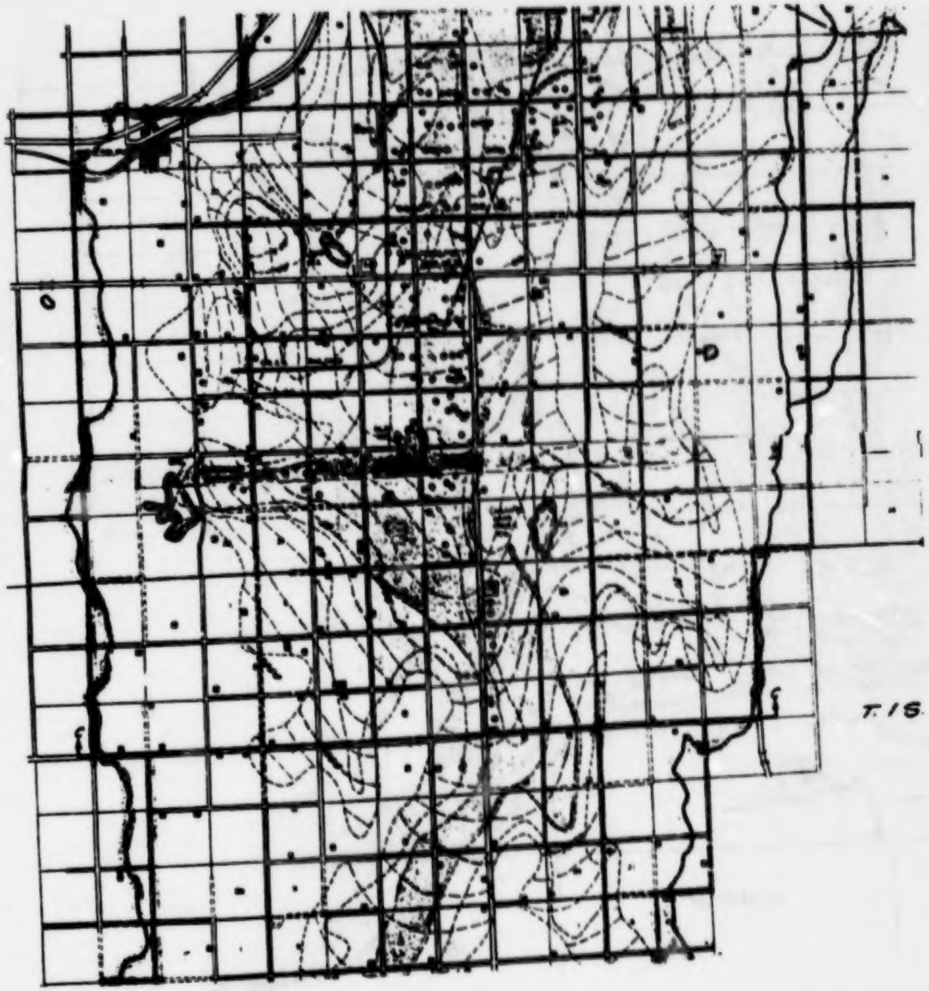
Attachment to
Letter #44



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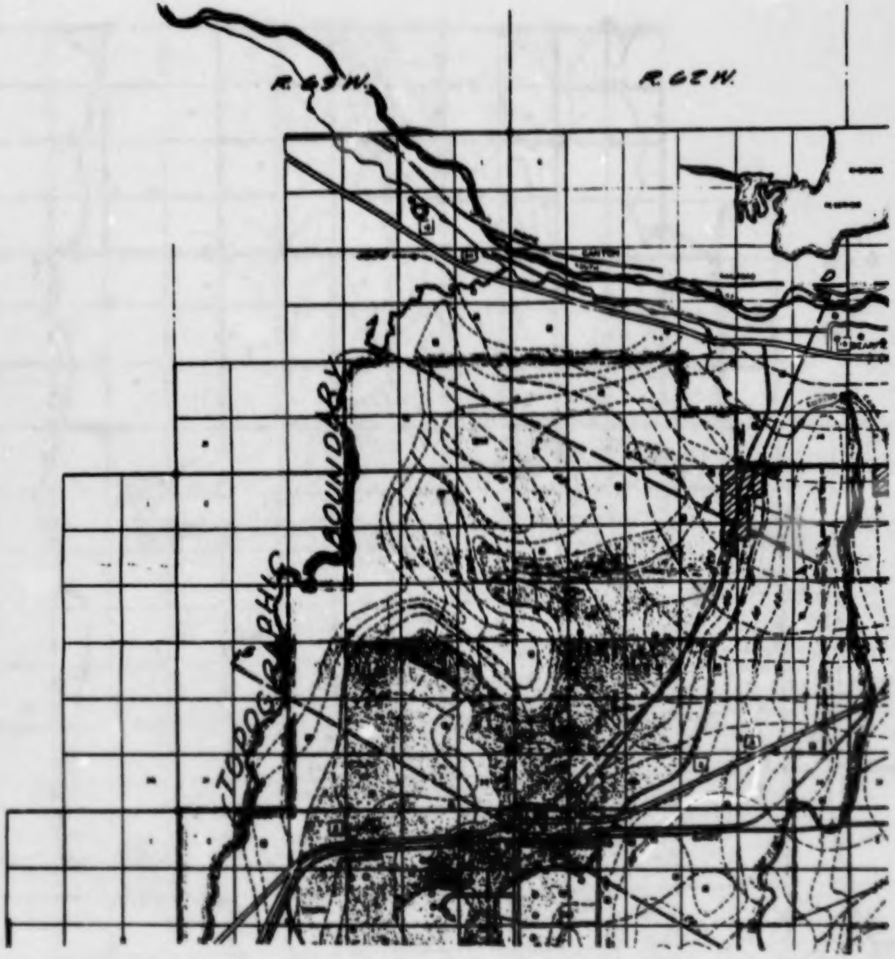
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R. 62 W.
BOUNDARY
TOPOGRAPHIC

Sept. 9, 1976

Letter #45 To: N.E.P.A.

From: John E. Meyer
R.R.1 Box 87
Bennett, Colo.

Re: METRO SLUDGE

I want to make a few coments about the use of sludge on farm land.
After talking to several farmers surrounding site B-2 and as far as
Byers, in the Prospect Valley area, and the Watkins farmers will have
① no use for sludge. You state by 1985 100,000 acres will be needed
for sludge application. By the report it seems that farm land is the
② biggest dumping ground and if farmers say no to sludge that stockpiles
of sludge are going to get mighty tall. If they, Metro Sludge, can
push this on us, then we as farmers have no rights left in this country.
③ I wonder how many Metro citizens would turn around and use sludge on
their lawns and gardens?
④ Land values were discussed in the book, stating that this would
have no effect on land values. It was my understanding that this is the
reason that future developement of Lowry is impossible. You must wonder
how many people would like to build around sludge. Would you?
⑤ Sludge is Metro's problem. Why should it be the farmers? We didn't
have anything to do with it's development . Many older families came
here when nobody else wanted the land. It seems like the drought of
the thirties, flood of 1965, and today's market prices are enough
problems to partake, must you also push problems like this back on them.
I am sure that every person's values his property highly because
it is something that he and she and both have worked for and paid highly
Metro sludge thinks that it has the right to come into a community and
say here we are going to put sludge plant and have the property owner
in that community not fight for their rights.
We always hear the statement this year because of our 200th
Birthday "We came a long way America". Have we came far enough that one
party can overtake another man's property because they need it for sludge?
In closing I quote many farmers young and old "the farmer doesn't
want Metro Sludge". Thank You

John E. Meyer

EPA Response

① On page 105 of the EIS, Volume I, EPA indicated that up to 40,000 ha
[100,000 acres] of dryland farms would be needed by 1985 to spread the
quantity of sludge available from the drying basins. It is highly
unlikely that Metro sludge would ever be used in great quantities on
dryland operations because of cost and the close tolerances required
on nutrient application. Metro feels that most of the sludge will
be used on irrigated farmland, mine spoil areas, municipal parks,
and sod farms. Substantially less acreage would be needed because
greater nutrient loading would be required.

② Metro has about two years of storage for dried sludge in the
proposed stockpile areas. If sludge could not be distributed for
one reason or another, Metro would haul the sludge to the Lowry land-
fill for burial.

③ Many urban citizens are interested in using sludge on lawns,
ornamentals, and even gardens. See Appendix F of the EIS, Volume I.
EPA does not think that sludge should be used in home vegetable
gardens, especially on leafy vegetables or edible root crops. See
discussions of use, Issue V-2.

④ The effect of the drying and distribution center on land values
in the area is discussed in Issue II-4.

⑤ The problem presented here is, unfortunately, difficult to resolve
to everyone's satisfaction. Public utilities in general and sewage
treatment facilities in particular do not usually make welcome neigh-
bors. However, they are a necessary part of modern life and have to
go somewhere. The proposed project is being designed to minimize as
much as possible the adverse impacts at the site and elsewhere. This
EIS process is the means by which these impacts are assessed and, if
possible, reduced to as low a level as possible. It is hoped that
eventually the resources represented by sludge will be viewed as an
asset, not a liability, to the local residents.

Letter #46

September 9, 1976

Testimony of Weld County
Denver Metro Sludge Management Plan
Draft EIS May 1976

Position: The position of Weld County regarding the recommended alternative presented is negative.

① The sludge drying facilities will have negative impacts on Weld County with: 1. deterioration of ground water quality due to leachates carrying salts, including nitrates, to the water table; 2. odor from the drying basins and stockpiles; and, 3. loss of irrigation water due to use in transport.

② A sizeable parcel of agricultural land area in Adams County will be removed from production.

③ The sludge reuse area will have a negative effect on Weld County with: 1. introduction of heavy metals into the soils and food chain creating hazards to human consumption and possible crop yield reduction; 2. hazards of parasite longevity in the sludge; 3. water quality degredation due to leaching; 4. air quality degredation due to particulates and aerosols; and, 5. long term impacts of accumulation of trace elements which become inhibitors of plant growth, salt accumulations which become plant growth inhibitors and potential ground water pollutants, heavy metal accumulation which affects the food chain, and nitrate pollution and eutrophication of surface water due to run off and irrigation tail water.

④ Control and mitigation measures are not clear nor are they adequately defined regarding the concerns of Weld County. Management techniques regarding sludge application leadings are not developed to a sophistication that define accurate practices.

⑤ Water pollution of ground water which will ultimately affect Weld County is expected from sludge drying. Southern Weld County is currently affected by high nitrates and undisolved solids in domestic and municipal water supplies. Accumulative effects to this problem will be detrimental to those supplies. The actual contamination of the ground water and the extent of that ground water pollution is not defined. The proposal does not define mitigation or management techniques of the drying site. Corrective action procedures are not developed to reclaim polluted ground water from the escaped contaminates.

If the proposed alternative is selected, site B-2 appears to be the best alternative for the drying facilities. Weld County would require drying beds to be completely lined to avoid leachate of contaminates into the ground water. Also test holes must be required to moniter the ground water affect by the drying facilities. Complete mitigation and management practices must be detailed and approved prior to operation.

Continued next page

EPA Response

① Each of these impacts has been recognized in the EIS. Discussions of these problems and potential resolutions are found under Issue II-2, (groundwater), Issue II-3 (odors), and Issue I-3 (water rights).

② This impact is discussed under Issue II-8. EPA believes the loss of farmland and productivity to be relatively small.

③ All of these potential impacts are discussed under the following topics: heavy metals, Issue I-1; parasite longevity, Issue V-1; water quality, Issue II-2; air quality, Issue II-5; and long term impacts under Issue V-5. EPA does not believe that any serious air or water quality impacts will occur with proper sludge applications, particularly if irrigated farmland is used.

④ The State of Colorado is formulating regulations on the utilization of sludge for both agricultural and other uses. EPA will not allow Metro to distribute sludge except to municipalities until these regulations are finalized. EPA will also recommend specific measures for management and control to the Metro District (see Appendix A and discussion under Issue V-4).

⑤ EPA will require lining of the basins at the B-2 site, as well as continuous monitoring and an emergency plan for pumping in the event that pollutants are detected. See discussion under Issue II-2.

Letter #46, continued

⑥ If sludge application is to be considered on land in Weld County, complete management and record keeping techniques must be developed and more detailed data regarding application loadings must be obtained prior to actual application.

⑦ It would appear to Weld County that other alternatives discussed for Metro Sludge disposal may be more environmentally sound and have less impact on Weld County than the selected alternative. It appears that economics have been the major factor in determination of alternative selection. Weld County would suggest a more complete review of other alternative that may require more capital expenditure but would be more environmentally sound.

EPA Response

⑥ EPA agrees that a system of record keeping is important for the management and control of sludge. EPA will recommend a system to Metro; however, state controls will have primacy.

⑦ Economics have not been the prime consideration in EPA's determination that the proposed system should be implemented. There is an institutional problem involved in the National Environmental Policy Act procedure as it applies to municipal wastewater treatment grants. In the past and in this case as well, the EIS was not developed until Metro had already gone thru its own evaluation process and selected the land application alternative. EPA is in the position of having to make an overall judgment about the merits of a selected proposal against other possible but often not as intensely evaluated alternatives. EPA's position has been that it will accept Metro's reasoning and data on the subject unless it has reason to question the logic or data. We have differences over specific portions of the project and differences in judgment as to whether factors, such as the presence or absence of a ready market, are critical or not to the overall "success" of the project. EPA and Metro do agree in principle, however, that a land recycling approach for wastewater sludge is a desirable way to proceed, unless there are substantial adverse effects in doing so. The problems so far raised, the critical ones such as groundwater problems, do appear to have mitigating solutions. Most of the other areas of concern—heavy metals, ready markets, means of control, etc.—are areas of uncertainty. Data is not definite enough to be able to make certain statements on most of these issues. Two positions are clear, however: 1) the Metro system will "work", at least to the extent sludge will be converted into a more usable and disposable form; 2) the type of sludge created does have enough nutients and soil-building materials to warrant this type of approach. There are also some minor adverse impacts that would occur no matter where this system would be implemented: loss of soil where the basins are constructed, some odors, and some resentment by people living in the area. EPA is also willing to look at other alternatives in detail, if this system should prove to be politically infeasible.

Reproduced from best available copy.

Letter #47

EPA Response

This petition contains the names of 292 persons in the general vicinity of the proposed B-2 drying site who are opposed to the project. A number of the persons on this list have stated their objection to this project through letters in this document or at the public hearings. EPA can only anticipate that the sludge drying project will not be able to utilize very much of the dry-land farm operations in the rural Adams County area with this kind of opposition.

AGAINST SLUDGE

292 Names

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
Helen A. Steele	Helen A. Steele	Box 292 Bennett Co 80102
E. [illegible]	E Iona Flanders	Box 33 Bennett Co. 80102
Norman F. Toft	Norman F Toft	Rt 1, Box 120 Bennett, Colo 80
Thelma L. Thornburg	Thelma L Thornburg	Rt 1, Box 2, Bennett, Colo 801
J. H. Toft	J.H. Toft	Box 378 Bennett Colo 80102
F. M. Toft	F.M. Toft	Box 124 Bennett Colo. 8010
Mildred M. Blake	Mildred M. Blake	Box 21, Bennett, Colo 80102
Betty [illegible]	Betty Steffen	Box 215 Bennett, Co 80102
[illegible]		[illegible]
James F. Steffen	James F Steffen	Box 215 Bennett Colo 8010
Helen [illegible]	Helen Bonds	Box 03 Strasburg Colo 801
Mary L. White	Mary L. White	Box 117 Bennett, Colo 801
Mary [illegible]	Mary Mahrenfie	Box 351 Bennett, Colo 80102
Marilyn Porter	Marilyn Porter	Rt 1 Box [illegible] Bennett Colo 80102
Chloris Sherer	Chloris Sherer	Box 404 Strasburg Colo 80136
John Sherer	John Sherer	Bennett Colo 80102
John R. Hetrick	John R Hetrick	Bennett
Mrs. Donald A. Frick	Donald A Frick	Byers, CO 80103
Mrs. L.C. Iseli	Mrs. L.C. Iseli	Bennett, Colo. 80102
Frank Steffen	Frank Steffen	Bennett Colo. 80102
Janet K. Meyer	Janet K Meyer	Bennett Colo 80102
[illegible]	[illegible] Duane	Rt 1 Box 111 Bennett, Colo
Cla Guernsey	Cla Guernsey	[illegible] Bennett Colo.
[illegible]	[illegible] Mullen	Box 366 Bennett Colo
[illegible] Morgan	[illegible] Morgan	Box 352 Bennett Colo

Continued next page

Letter #47
continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
Harry Davis	HARRY DAVIS	Box 126 Watkins Colo
Ramona Davis	Ramona Davis	Bx 126 - Watkins Colo.
Helen Rodehurst	Helen Rodehurst	Bx 197 - Bennett, Colo
M.V. Greene	M.V. GREENE	LIMON, Colo 80828
Pauline Bogart	Pauline Bogart	Box 138 Bennett, Colo
[illegible]	[illegible] C. Jones	675 4th ST Bennett Co.
Billie K. Jones	Billie Jones	675 4th ST. Bennett Co.
Jon Sutton	Jon Sutton	Box 37 Bennett Co
Georgia [illegible]		Bennett
Bill Behrens	Bill Behrens	Watkins Co.
Bill [illegible]	Bill [illegible]	2965 [illegible]
Glenda K Collie	Glenda K Collie	650 [illegible] 80102
[illegible]	[illegible]	245 Washington St [illegible] Colo
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] Bennett Colo
[illegible]	[illegible]	Box [illegible] Bennett
[illegible] McConnell	Linda McConnell	Box 305 Bennett, Colo
Harriet Ellis	Harriet Ellis	Box 137, Watkins Colo 80137
Jim Bennett	Jim BurneT	Box 21 Bennett Colo 80102
[illegible]	[illegible]	Box 163 Bennett Colo 80102
Carol Taft	Carol Taft	Box124 Bennett, Colo 80102
[illegible] Hunter	DeLores Hunter	Box 14 Bennett, Colo 80102
[illegible]	[illegible]	Box 63 Bennett, Co 80102
Nancy Lantz	Nancy Lantz	Box 303 Bennett Co 80102
Jeanne E. Thain	JEANNE E. THAIN	Box 205 Bennett Colo 80102

Continued next page

Letter #47
continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
Karen Mannon	Karen Mannon	Box 291 Bennett, Colo.
Sandra K. Snider	Sandra K. Snider	Box 368, Bennett, Colorado
Katherine Trupp	Katherine Trupp	Star Route Bennett Colo
Scott A Goodwin	Scott A. Goodwin	555 4th St Bennett, Colo.
Jessie Janaway	Jessie W. JANAWAY Sr.	440 2nd. St. Bennett Colo. 80102
[illegible]		Box 271 Bennett Colo.
[illegible]		Box 271 Bennett Colo.
[illegible]		Watkins Colo
[illegible]		Watkins Colo
[illegible]		Bennett Colo.
Everett Karr	EVERETT KARR	P.O. BOX 311 BENNETT Colo 80
[illegible]	Kenneth R. [illegible] Jr	PO Box 265 Bennett Colo 80102
Rhonda [illegible]	Rhonda Hinknecht	PO Box [illegible] Bennett, Colo 80102
Mike [illegible]	Mike Dorris	PO Box 243 Bennett, Co 8010
W.B. Gaines	WB GAINES	BOX 325 BENNETT Colo
RB Curtis	RB CURTIS	R1 BOX 9B BENNETT Colo
Helen Curtis	Helen E Curtis	R1 Box 9B Bennett Co 8010
[illegible]		580 2nd St Bennett
[illegible]		580 2nd St Bennett
[illegible]		Bennett Colo
[illegible]		Bennett Colo
Effie Henderson		
Lou Ann Cook	Lou Ann Cook	Watkins, Colo
[illegible]		Bennett [illegible]

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Letter #47 continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
William E Sweet	William E. Sweet	Box 249 Bennett Colo [illegible]
Bruce E Lentz	BRUCE E LENTZ	BOX 303 BENNETT Colo 801[illegible]
	BRADLEY, EARL	Box 73 WATKINS Colo 8013
Jacqueline Lentz	Jacqueline Lentz	Box 206 Bennett, Colo
Ted W. McCarty	Ted W. McCarty	Star Route Box 65 Bennett Colo.
[illegible]	[illegible]	[illegible]
[illegible]	H. Rinehart Baker	1st & Washington Bennett, Col.
Selma Kieper	Selma A. Kieper	3rd Hunt - Bennett Col.
[illegible]	[illegible]	[illegible]
Wayne Mitchell	WAYNE MITCHELL	BOX 767 BENNETT, COLO.
Dick Pritchard	Dick Pritchard	Bennett, Colo 80102
Bob Taylor	Bob Taylor	Box 108 Bennett Colo 80102
Alvina Rybicka	ALVINA RYBICKA	Route 1 - Bennett Colo 80102
[illegible]	Charles Stratton	Bennett Colo
Susan Davis	Susan DAVIS	Bennett Colo.
Kent Crisman	Kent Crisman	Bennett Colo 80102
Bonnie Crisman	Bonnie Crisman	Bennett Colo 80102
[illegible]	RICHARD MANNING	Bennett Colo 80102
Marie A. Behrens	MARIE A. BEHRENS	WATKINS Colo 80137
[illegible]	[illegible]	Bennett Colo
Davis Crisman	Davis Crisman	Bennett, Colo 80102
Lloyd Snider	LLOYD SNIDER	Bennett Colo 80102
Homer Goodwin	Homer Goodwin	Bennett Colo, 80102
Hazel Cottrell	HAZEL COTTRELL	Bennett Colo 80102

Continued next page

Letter #47, continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
James R. Stutz	James R. Stutz	Box 358 Bennett, Colo
[illegible]	Sue T PRICE	Rt. 1 [illegible] Bennett Colo.
Gerald R Toczek	Gerald R Toczek	[illegible]
Dollie Toczek	Dollie L Toczek	
Ray Breidel	Ray Breidel	BOX 17 Bennett Co
[illegible]	[illegible]	Bennett Colo.
Ronald Richardson	Ron Richardson	Box 208 Bennett
[illegible]	Joseph Chase	Box 135 Bennett
[illegible]	[illegible]	Rt 1 Box [illegible] Bennett
[illegible]	Margaret J [illegible]	Rt 1 Box 115 Bennett
Bradley J Witt	Bradley J Witt	Rt 2 Box 18 "
[illegible] E. Johnson	[illegible] E. Johnson	Rt 1 Box 21
[illegible]	Dale E. [illegible]	Rt 1 Box [illegible] Bennett
John Finnity	JOHN FINNITY ~~Box Bennett~~	Box 86 Bennett
Wanda M Davis	WANDA M DAVIS	Box 323 Bennett, Co.
Barbara Leonard	Barbara Leonard	Box 244 Bennett Co
Charles Breech	Charles Breecher	Box 111 BENNETT Colo.
Mark Sears	Mark Sears	Box 297 Bennett Co.
[illegible]	[illegible]	[illegible] Bennett, Co
James M. Ewing	James M. Ewing	Box 54 Bennett
John Meyer	John Meyer	Rt 1 Box 17 Bennett
Robert Behrens	Robert Behrens	Rt 1 Box 101 Bennett
Ted Keller	Ted Keller	Bennett, Rt 1 [illegible]
Henry Meyer	Henry Meyer	Bennett Colo.

Continued next page

Letter #47 continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
Martha L. Gregg	Martha L Gregg	Bennett Colo
John H. Clair	JOHN H CLAIR	Bennett Colo
Marjorie Hendrix	Marjorie Hendrix	Bennett, Colorado 80102
[illegible]	Richard H. Hendrix	Bennett, Colo 80102
Robert Meyer	ROBERT MEYER	Bennett, Co.
Peggy Burton	Peggy Burton	Bennett Colo.
John W. Clair	John W. Clair	Bennett Colo
Howard Nordahl	Howard Nordahl	Bennett Colo
Melvin R. Layne	Melvin R Layne	Bennett, Colo
[illegible]	[illegible] Layne	Bennett Colo [illegible]
Byron H. Trupp	Byron H Trupp	Bennett Colo 80102
Thelma J. Trupp	Thelma J. Trupp	Bennett, Colo 80102
James [illegible]	~~[illegible]~~	Bennett, Colo [illegible]
[illegible]	[illegible] Layne	Bennett, Colo [illegible]
Kenneth L Bowman	Kenneth L Bowman	Bennett Colo 80102
Mary Jo Bowman	Mary Jo Bowman	Bennett, Colo 80102
Owen Fisher	OWEN FISHER	Commerce City 80022
Gladys Fisher	GLADYS FISHER	Rt. Box 70 " Colo. 80022
Sam Steele	SAM STEELE	Box 292 Bennett, Colo 80102
Virgil Piland	Virgil Piland	Rt 1 Bennett Colo 80102
[illegible] Piland	JonLee Piland	Rt 1 Bennett Colo. 80102
Sara Piland	Sara Piland	Bennett, Colo 80102
[illegible]	Terrance [illegible]	Bennett Colo. [illegible]
Brent A White	Brent A White	Bennett Colo 80102

Continued next page

Letter #47, continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
	W. T. ZUBER	Box 236 Bennett Colo
	Mrs Terry Davis	Rt 1 Box 49A - Strasburg, Colo.
	Kenneth Schwaners	P.O.B. 436 Strasburg Colo
	Dorothy Schwaners	P.O.B. 436 Strasburg, Colo
W. E. Pope	Thelma Pope	Strasburg Colo
	Glenna Brackman	Strasburg, colo
	Arthur D. Rainier	P.O. Box 356 Bennett Colo.
Albert R. Meyer	Albert R Meyer	Box 105 Bennett, Colo 8010
Vivian L. Meyer	Vivian L. Meyer	Box 105 BENNETT, Colo.
David Nelson	David Nelson	Box 281 Bennett, Colo
Eloy Santistevan	Eloy Santistevan	P.O. BOX 187 STRASBURG, Colo
	Thomas Middlemist	Rt 1 - Box 136 Strasburg Colo
Helen Santistevan	Mrs Eloy Helen SANTISTEVAN	PO BOX 187, STRASBURG Col
	Vivian R Meyer	Bennett, Colo.
	[illegible]	Rt 1 - Bennett Co
Del Kaufman	Del Kaufman	Bennett, Co
Shirley Coleman	Shirley Coleman	Bennett Colo
Cheryl Marshall	Cheryl Marshall	Box 115 Bennett Colo
	[illegible] Bunstrom	Box 228 Bennett, Colo. 80102
STEVEN W. RAKUSKY	[illegible]	BOX 81 BENNETT COLO 80102
Michael Stewart	Michael Stewart	Box 136 Bennett Colo
Robert E. Gray	Robert E. Gray	P.O. Box 292 Strasburg Co 80136
Danita Dalton	Danita Dalton	Box 102 BENNETT Colo 80102
Cheryl Becker	Cheryl Becker	Bennett, Colo 80102

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Letter #47
continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

	SIGNATURE Kalcevic Frank	PRINT NAME	ADDRESS
	By John Kalcevic	John KALCEVIC	#261 County Hills Drive Brighton
1	Lawrence E. Wakes	LAWRENCE WAKES	Bennett, Colo.
3	John C. Saeler	JOHN C. SAELER	Bennett, Colo.
4	Ronald D Werner	Ronald D Werner	Bennett Colo
5	Wayne D. Beltz	WAYNE D. BELTZ	Keenesburg, Colo (ADAMS)
6	E. D. Beltz		" " "
7	Dave Gage	Dave Gage	" " "
8	Catherine Mirador	Catherine Mirador	Bennett Colo
9.	Chris A. Wailes	Chris A. Wailes	Bennett Colo.
10.	Jim Pugh	Jim PUGH	R1 Box 63 Commerce City
11.	Margaret Blankley	Margaret Blankley	Box 237 Watkins Colo
12	Edythe Tupps	Edythe Tupps	Box 218 Watkins, Colo. 80137
13	Calvin Lee Tupps	Calvin Tupps	Box 218 Watkins Colo 80137
14	John A. Blankley	JOHN A. BLANKLEY	Box 237 WATKINS Colo 80137
15	J.W.C. Davis	J.W.C. DAVIS	Bennett Co.
16	Gwen Davis	Gwen Davis	Bennett Colo. 80102
17	Earl Crisman		Bennett Colo 80102
	John F. Davis	John F Davis	Bennett Colo. 80102
19	James W. Gregg	JAMES W. GREGG	Bennett Co 80102
20	[illegible]		
21	[illegible]		" " "
22	[illegible]		Bennett Colo 80102
23	Russell Piland	Russell Piland	Bennett Colo 80102
24	Lillian Warner	Lillian Warner	Box 34, Rt 1 Bennett, Colo. 80102

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Letter #47
continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
Jess McKinster	JESS McKINSTER	PARKER COLO
Lonnie Mathis	LONNIE MATHIS	Rt 1 Commerce City
Loyd D Wilfoth	LOYD WILFOTH	Bennett Colo
Vivian E. Ader	VIVIAN E. ADER	Watkins Colo 80137
Nora E Wagner	Nora E Wagner	Bennett Colo
Jim Wagner	Jim Wagner	Bennett Colo
[illegible]	MCE. Tupps	Watkins Colo
Edward Jacoby	EDWARD JACOBY	Bennett Colo
Irene Jacoby	IRENE JACOBY	Bennett Colo
[illegible]	B.J. SCHROTH	Bennett Colo
Walter G Schroth	Walter G Schroth	Bennett Colo.
Ruth Cummings	Ruth Cummings	Watkins Colo 80137
William E Cummings	W E Cummings	Watkins Colo 80137
Mike [illegible]	Mike Pinzenscham	Bennett Colo 80102
Dan Kugler		Bennett - Colo
F. Earl Tupps	F Earl Tupps	Watkins, Colo
Edith D Marlott	Edith D Marlott	Byers, Colo
George Dalrymple	R George Dalrymple	Bennett Colo
VIRGINIA HARTNAGLE - Printed		
Virginia Hartnagle		LONGMONT, COLO.
Leslie J Mathis	LESLIE J. MATHIS	BENNETT.
Patricia R Freeman	Patricia Freeman	Bennett Colo
Van L Teagard	VAN L. TEAGER	Box 364 Bennett, Colo
Mrs. W.W. or Anna	Stinnett	R.1. Box 279A Brighton

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Letter #47
continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
Bettie Metcalf	BETTIE METCALF	Rt 1 Box 2A BENNETT 80102
Ray J. Austin	RAY J. AUSTIN	7033 QUAIL ST ARVADA, Colo
	DEAN A. TRUPP	Bennett, Colo 80102
Clifford Adee	C.W. Adee	Watkins Colo 80137
Veronica Brinkman	Veronica Brinkman	Box 46 Bennett Colo 80102
Joy L. Kreitzer	JOY L KREITZER	R4, Box 255, Brighton, Colo.
Paul Frey	Paul Frey	Box 10 Bennett Colo
Rose Frey	Rose Frey	Box 10 Bennett Colo
Margaret Anderson	Margaret Anderson	Bennett Colo
Geo B. Anderson	Geo. B. Anderson	Bennett Colo.
Robert T. Rickard	Robert T. Rickard	Star Route Box 61, Hudson, Colo.
	MILTON SAYLER	Aurora, Colo
Pat Siegman	PAT SIEGMAN	Box 234 · Bennett Colo 80102
	BRIGHTER STRASBURG	JAYCEES
Jim Lamb	Jim Lamb	Rt. 1 Box 121 Bennett,
Dave Harrington	Dave Harrington	Rt 1, Box 51C Strasburg
	Paul Whiles	Bennett Colo 80102 Box 41
W. S. Canterbury	W.S. CANTERBURY	Rt 3 Box 192A Brighton Colo
	Margaret Knievel	Star Rt Box 57 Hudson Colo
	Del Kninger	Star Rt. Box 57 Hudson, Colo
Ann Ziegler	Ann Ziegler	Rt. 1 Box 79 Commerce City Co.
Esther Canterbury	Esther Canterbury	Rt 3 Box 192A Brighton Co. 80601
Fred Meyer	FRED MEYER	RR #1 BENNETT Colo
David Small	DAVID SMALL	Bennett, Colo 80102

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Letter #47
continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
Norlin Cavender	NORLIN CAVENDER	Bennett, Colo 80102
Stan Egan	STAN. EGAN	RT 1 Box 82 COMMERCE CITY 80022
Richard Horth	Richard Horth	1st Rt. Box 49 Hudson, Colo
Lawrence Flanders	LAWRENCE FLANDERS	— P. O. Box 33. Bennett, Colo
H Wayne Tapps	H. WAYNE TAPPS	RT 1 Box 14 Bennett, Colo
BOB HERRINGTON	BOB HERRINGTON	RT 1 Box 51C STRASBURG
Lee A Tangeman	Lee TANGEMAN	Box 394 Strasburg Colo
V W Stinnett	V W STINNETT	R 1 Box 27EA Brighton Colo
[illegible]	ROBERT YOUNKER	R1 Box 196A Keenesburg Colo [illegible]
Oliver Morris	Oliver Morris	Rt 1 Box 37 Comm City Colo 80022
Marvin Helzer	Marvin Helzer	Rt 1 Box 51 Bennett Colo 80102
Ira Mallett	IRA MALLETT	Byers Colo.
E F Hartnagle	E.F. HARTNAGLE	718-15th Longmont, Colo. [illegible]
Madeleine R Cimpotte	MADELEINE R Cimpotte	17201 E 136th Ave Brighton Colo 80601
Jay O Guy	JAY O GUY	Rt 3 Box 262 Brighton Colo 80601
Verla F Small	VERLA F. SMALL	Bennett, Colo. 80102
James E Froman	JAMES E. FROMAN	R1 Box 51 Bennett Colo.
Gailen R Weller	GAILEN R WELLER	565 3rd BENNETT Colo 80102
Dorothy Guy	DOROTHY GUY	Rt. 3 Box 262B - BRIGHTON, Colo 80601
Robert Ziegler	Robert Ziegler	Rt 1 Box 79 Commerce City 80022

Continued next page

Letter #47
continued

We, the undersigned residents and/or landowners of eastern Adams County DO NOT APPROVE of Metro Denver Sewer spreading the sludge of its operation in eastern Adams County.

SIGNATURE	PRINT NAME	ADDRESS
Mrs Donna Wailes	Mrs. Donna Wailes	Box 41- Bennett, Colo 80102
Ms Rose Wenzel	Ms. Rose Wenzel	6715 Main Brighton Colo 80601
Jo E. Meade	Jo E. MEADE	560 4th St. Bennett, Colo.
Tom Brockman	TOM BROCKMAN	555 Kiowa Pl Bennett Colo
~~Tony J. Kraitzer~~		
Tony Kraitzer	TONY KRAITZER	Rt 4 Box 255 Brighton Colo
Elmer Piland	ELMER PILAND	Bennett, Colo. Box 371
Boyd Piland	Boyd Piland	Bennett Colo. Box 371
Calvin Lee Tappe		
John R. Jacoby	JOHN JACOBY	Bennett Colo
Wilbur D. Packard	Wilbur D Packard	Rte 1 Box 276 Brighton Colo.
Tom Siegman	TOM SIEGMAN	Box 234 Bennett, colo
Mr & Mrs [illegible]		Commerce City Colo.
Alex Middlemist	Alex Middlemist	Route 1 Box 136, Strasburg, Colo.
Clyde E. Lewis	CLYDE E. LEWIS	Box 141, Strasburg, Colo
Elroy J. Smith	Elroy J. Smith	Box 66 Commerce City, Colo.
Frank Hartnagle	FRANK HARTNAGLE	E-718-15th LONGMONT, Colo.
Paul C. Warner	PAUL C. WARNER	Rt 1 Box 85 COMMERCE CITY
Connie E. Warner	Connie E. Warner	Rt. 1 Box 85 Commerce City Colo
Robert E. Johnson	Mr & [illegible]	9970 [illegible] Denver 80221

Letter #48

A RESOLUTION OPPOSING THE DUMPING OF SLUDGE
FROM METRO SEWAGE DISTRICT IN ADAMS COUNTY.

#76-24

WHEREAS, Metro Sewage District has historically dumped sludge from disposal plants at the Lowry Bombing Range; and

WHEREAS, the dumping of sludge at the Lowry Bombing Range has contributed to the deterioration of the environment for the surrounding area; and

WHEREAS, this process of disposal of sludge has created noxious odors and a potential health hazard for the general public; and

WHEREAS, the dumping of sludge has rendered areas of Lowry Bombing Range unsuitable for reclamation.

NOW THEREFORE, BE IT RESOLVED that the City Council of the City of Brighton vehemently opposes the dumping of sludge in Adams County.

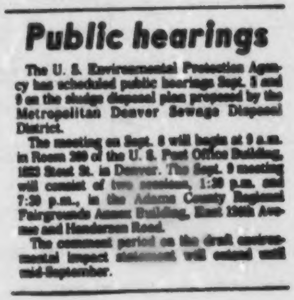
BE IT FURTHER RESOLVED that the City of Brighton pursue every legal mechanism to prohibit the dumping of sludge by Metro Sewage District at the Rocky Mountain Arsenal or at any location within Adams County.

ADOPTED this 3rd day of August, 1976.

Mayor

Attest:

City Clerk



Public hearings

The U. S. Environmental Protection Agency has scheduled public hearings Sept. 8 and 9 on the sludge disposal plan proposed by the Metropolitan Denver Sewage Disposal District.

The meeting on Sept. 8 will begin at 9 a.m. in Room 269 of the U. S. Post Office Building, 1823 Stout St. in Denver. The Sept. 9 meeting will consist of two sessions, 1:30 p.m. and 7:30 p.m., in the Adams County Regional Fairgrounds Annex Building, East 124th Avenue and Henderson Road.

The comment period on the draft environmental impact statement will extend until mid-September.

EPA Response

The City of Brighton is opposed to any "dumping of sludge" on the Rocky Mountain Arsenal or anywhere in Adams County, in view of the experiences at Lowry Bombing Range. It is somewhat understandable that the city of Brighton is opposed to further activities that could endanger their water supply, especially as a result of activities on the Arsenal, and the long history of poor sewage treatment effects on Barr Lake. It is also somewhat unfortunate that the city was so non-specific about the type of operation proposed. Metro will not be dumping sludge in terms of disposing of it at the proposed B-2 site. Disposal if necessary will continue to take place at the Lowry Bombing Range. Sludge applications could take place in Adams County, but only at agronomic rates intended to maintain agricultural production.

Letter #49

The Board of Directors of the Brighton Chamber of Commerce have unanimously adopted a resolution opposing the dumping of sludge in Adams County. The dumping of Metro Sewage District's sludge was seen by the Board as a detriment to the quality of life in Adams County and especially the Greater Brighton Area. The dumping would be in direct contradiction to the Chamber's goals of improving the area for living, farming, and doing business.

The resolution is as follows:

WHEREAS, the dumping of Metro Sewage District sludge would substantially deteriorate the environment of the surrounding area as it has at the Lowry Bombing Range; and

WHEREAS the process of disposal of sludge has created noxious odors and a potential public health hazard; and

WHEREAS valuable land could be rendered unsuitable for reclamation.

NOW THEREFORE, BE IT RESOLVED that the Board of Directors of the Greater Brighton Area Chamber of Commerce opposes the dumping of sludge by the Metro Sewage District in Adams County.

ADOPTED this 27th day of August, 1976.

David W. Graybill
David W. Graybill
Executive Vice President

EPA Response

It is also not clear what is meant by the "deteriorated environment" at the Lowry Bombing Range. Metro sludge applications before 1972 did cause an odor problem, due in part to the kind of sludge applied and the form of operation. We believe that this problem has essentially been corrected. Furthermore, the Lowry operation includes the Denver landfilling operation which probably poses a greater environmental long-term hazard than Metro's sludge landspreading. Metro's rates of applications are now in excess of agronomic rates, but given enough time, there is still the strong likelihood that the area of Metro sludge applications could revert to productive grazing land. A groundwater study by USGS has shown that although some well contamination has taken place, this could be due to surface runoff in certain areas. The type of system proposed by Metro is intended to eliminate this form of concentrated dumping of sludge in a small area. The impacts are severe because too many nutrients as well as metals have been loaded into one area; overfertilization could create the same problems.

Letter #50

CITY AND COUNTY OF DENVER

W. H. McNICHOLS, JR.
Mayor

DEPARTMENT OF PUBLIC WORKS

WASTEWATER MANAGEMENT DIV.
5055 WASHINGTON STREET
DENVER, COLORADO 80216

September 8, 1976

U. S. Environmental Protection Agency
1860 Lincoln Street
Denver, Colorado 80203

Gentlemen:

Re: E.I.S. for Denver Metropolitan Sewage Disposal District Sludge Management Plan

The draft Environmental Impact Statement as prepared by the U. S. Environmental Protection Agency relating to the sludge management plan of the Metropolitan Sewage Disposal District has been reviewed and evaluated. The City and County of Denver supports the concept of land disposal of sludge generated by the Metro and Denver Northside Treatment Plants. Specific comments relative to the draft impact study will be forwarded at a later date.

Sincerely yours,

J. Zohn, P.E.
Director

JZ:clj

EPA Response

No comment.

Letter #51

Statement by Alan L. Canter, Chairman
Metropolitan Denver Sewage Disposal District No. 1
at the September 8, 1976
Public Hearing by U.S. Environmental Protection Agency on the
Metropolitan Denver Sewage Disposal District No. 1
Sludge Management Plan

We wish to compliment the Environmental Protection Agency on the depth and quality of the assessment of the impacts of the Metro Denver Sewage Disposal District sludge drying basin project. We are also pleased with the findings that the method proposed by the Metro District for drying and use of sludge for agricultural purposes is best for the metropolitan Denver area.

① We concur in your finding that no site location for any waste treatment facility is completely favorable considering all factors, and we are gratified in your finding that the proposed Site B-2 is a reasonable choice for such a facility site.

② On page 13 of the Environmental Impact Statement Summary is a statement to the effect that it is "somewhat distressing that little soils and groundwater information is available for proper evaluation of site differences and impacts". I would point out that detailed soils information is now available. Specific groundwater studies were not conducted, but wells in the area are more than 200 feet deep, and the potential for groundwater problems in this vicinity is thus remote.

③ Also on page 13 of the summary, the statement that the design of drying basins may need to be changed if a danger to groundwater quality exists is legitimate, and I would point out that the design of drying basins has been expected to be revised if needed. These revisions would be based on research projects which have been underway for more than a year, experience over the past seven years at the Lowry Bombing Range, and the soil test data from Site B-2 which are now being evaluated.

Continued next page

EPA Response

① From a technical standpoint, the B-2 site is reasonable. So are many others, including the Lowry Bombing Range. From a political standpoint, site B-2 does not look too promising (see Adams County Letter # 40, City of Brighton Resolution [Letter # 48], Petition [Letter # 47], and numerous citizen letters).

② EPA has utilized the Soils and Geotechnical Report from CH2M-Hill in its evaluation of groundwater problems at site B-2 (see Issues II-1 and II-2).

③ In discussions with the Metro District, EPA has agreed to proceed with the understanding that Metro agrees to meet performance standards to be set by EPA for a permeability rate limit for the drying basins, as well as a certain depth of impermeable barrier. Metro will have to demonstrate during construction that such limits are achieved.

Letter #51, continued

④ The statement on page 13 of the summary concerning the need to reduce the amount of cadmium or other heavy metals being allowed in the sewer system is noted, and you can be assured that the Metro District Board of Directors has the necessary legal authority and will take action to amend that portion of the Service Agreement if necessary.

On pages 13 and 14 of the summary is an indicated concern about controlling sludge application to agricultural lands. The 1976 session of the Colorado General Assembly amended the Colorado Solid Waste Disposal Sites and Facilities Act to make the Colorado Department of Health and the Colorado Department of Agriculture responsible for applicable regulations and control of sludge application on agricultural land. ⑤ It would be appropriate to assume that the state agencies will act responsibly in this regard. Appropriate state regulations are presently being formulated, and the Metro District will certainly comply with those regulations.

⑥ The suggestion on pages 14 and 19 of the summary for mitigating negative impacts at the Lowry Bombing Range by spreading sludge over larger areas of the bombing range can be helpful only if additional lands can be made available to the Metro District. At the present time all land which is actually available to the Metro District is being used for sludge recycle purposes. In addition, the Lowry operation still requires high expenditure of energy and money and high chemical content of the sludge cake, and we are trying to eliminate these. Of great environmental importance is the fact that the Lowry Bombing Range site has three drainage basins bringing surface water flow through the site, whereas proposed Site B-2 is located at the top of a drainage basin with much less drainage for which control would be required.

⑦ The statement on page 22 of the summary to the effect that EPA will require the Metro District to develop research sites should be tempered with the realization that the Metro District already has many

Continued next page

EPA Response

④ EPA will insist that Metro take all possible measures to reduce the heavy metals and toxic organic contributions from industrial sources into the Metro wastewater system. Metro should accelerate its industrial source survey program before construction of this project is begun. See Issue I-1.

⑤ EPA will require Metro to store sludge onsite or dispose of it by landfill (except for municipal use) until such time that the final regulations are put into effect by the State of Colorado. See Issue V-4.

⑥ We agree that it does not make sense to continue the same mode of operation at Lowry Bombing Range over greater areas. We do feel that consideration of Lowry Bombing Range as an alternative site for the Metro sludge should be pursued by Metro, even though technically the B-2 site is better. Land ownership of Lowry Bombing Range is complex, with the City of Denver, the State of Colorado, private parties and the U.S. Air Force owning various parcels in the area.

Letter #51, continued	EPA Response
⑦ research projects underway for the purpose of revising the design of the facility if needed, for preparation of an operations manual, and for developing a system for recommending sludge application rates and practices to the ultimate users.	⑦ EPA's intention here was to develop research data from ongoing studies by Metro at the Greeley test area. This information was provided to EPA.
⑧ The concern stated on page 27 of the summary in the event that there would be an inadequate market for sludge is probably not a valid concern. We have indications from a large number of individuals and agencies that a need and a desire for the dried Metro District sludge exists. In the unlikely event that there would be a market problem, the Metro District could truck the dried sludge to the Lowry Bombing Range, could truck the dried sludge to some other approved sanitary landfill, could burn the sludge as a fuel, or could use the sludge for a number of other purposes such as animal feed or poultry feed. It is improbable, however, that the Metro District would not have a sufficient market for the dried sludge production by the time the sludge drying facility would be in operation.	⑧ We reluctantly agree that the proposed drying system could still prove successful in cost-effective terms even if the dried sludge were to be trucked and disposed of at the Lowry Landfill. EPA does not think that the evidence has been presented that most or all of the sludge can be beneficially recycled at this point in time. However, EPA also thinks that developing such markets can come only after the system has been operational for a while. The research and demonstration proposed with this system is also critical in developing an understanding as to which potential markets would be best for this type of sludge. See Issue V-3.
⑨ On page 25 of the summary is a stated concern about airborne sludge problems. The design of the sludge drying facility provides for watering stockpiled sludge in the event of high wind problems.	⑨ EPA feels that Metro should give strong consideration to restoring the original concept of sunken earthen basins to store sludge, in order to lessen the windblowing potential. Also, Metro plans and specifications must contain a detailed plan for wetting and controlling sludge movement in the event of high winds. See Issue II-5.
⑩ The offensive odor problem mentioned on page 25 of the summary probably will not result based on decades of experience with anaerobically digested sludge, but in the event of an upset digester problem, the Metro District would store such sludge in a sludge holding tank and then provide subsurface injection under controlled conditions.	⑩ Although odors from the drying basins will be considerably less than that from undigested sludge and other normal wastewater treatment plant odors, there will still be an odor detectable from the drying basins. EPA will require an emergency disposal plan for sour digester contents. Metro should be prepared to compensate those two residences nearest the site to the north and east, in the event sludge odors prove to be a nuisance.
⑪ A general statement concerning the Environmental Impact Statement Summary would be in order. Some portions of the summary are not supported by the information contained in the draft Environmental Impact Statement. As an example, the advantages and disadvantages of using the Lowry Bombing Range as found on pages 27 and 28 of the draft Environmental Impact Statement do not support the inferences in the summary document that more consideration should be given to continued use of the Lowry Bombing Range site.	⑪ The final EIS and summary will hopefully be more consistent.

Continued next page

Letter #51 continued

⑫ Table A on page 5 of the summary indicates concentrations of major plant nutrients in sewage sludge and various other sources of fertilizer. It is suggested that a similar table be provided which would indicate the comparison of heavy metals found in commercial fertilizers and other fertilizer sources to that found in sewage sludge.

⑬ On page 20 of the summary as well as throughout the Environmental Impact Statement draft is the general statement that intensive monitoring would be required for this facility. It is important for all concerned to understand that intensive monitoring is a part of the design and operation plan for the drying basin site, and such intensive monitoring has been an important part of the total District plan not only for the future facilities but also for the past, present and future use of the Lowry Bombing Range site.

⑭ In the draft Environmental Impact Statement on page 84 reference is made to the cost of land for proposed Site B-2. The one statement which has an estimated cost of one million dollars for the site is a rough high cost estimate, and does not agree with the anticipated market value of the land.

Along with this statement we are submitting a separate document which includes numerous technical corrections for use in revising the final Environmental Impact Statement.

Again, I compliment the Environmental Protection Agency for the thorough job accomplished in assessing the environmental impacts of the proposed Metro District sludge drying basin facility, and thank you for the opportunity to present a statement at this public hearing.

WEK/j
8/31/76

Continued next page

EPA Response

⑫ EPA does not have this information at its disposal, although we are aware that commercial fertilizers do contain other materials, including some residual heavy metals.

⑬ Yes, we recognize that Metro is prepared to intensively monitor the groundwater around site B-2. EPA has prepared a suggested monitoring scheme that is contained in Appendix A; EPA will also require Metro to develop a plan of action for removal of contaminated waters that could affect any aquifers offsite. See discussion under Issue II-2.

⑭ This will be updated to reflect current costs.

Letter #51, continued

Corrections and Comments to Accompany Statement by
Alan L. Canter, Chairman
Metropolitan Denver Sewage Disposal District No. 1
at the September 8, 1976
Public Hearing by U.S. Environmental Protection Agency on the
Metropolitan Denver Sewage Disposal District No. 1
Sludge Management Plan

			EPA Response	
p.i.	2.	Description of action. Sludge production will be 107 dry tons per day, not per year.	p. i 2.	Corrected.
p.i.	3.A.(1)	EPA indicates that soil as an agricultural resource will be lost from the 600 acre drying basin. This is not necessarily the case. Irrigated farming could actually occur in the bottoms of the drying basins, which could in effect increase the agricultural output of the 600 acres as opposed to dry land farming now practiced.	p i 3A(1)	Restoration of this farmland will be essentially irreversible in the next 25-50 years. The possibility of long-term reclamation does exist.
p.i.	3.A.(2)	This item indicates that the ground water quality in the area of the sludge drying and distribution center will gradually be deteriorated by the leachates from the bottom of the drying basins, carrying salts, including nitrates, to the water table. From our field investigation no water was found at even 100 feet below the ground surface. Discussions with a farmer in the area of the drying center indicated that ground water is more than likely about 240 feet below the ground surface. A reasonable estimate would indicate that leachate from the basins would take many years, possibly longer than 100 years, to reach the ground water. The quality, as well as quantity, of the leachates is still unknown and both of these items can best be determined from field investigations after the system is operating. Because of the long period of time before the leachate could reach the ground water, ample opportunity is afforded to determine the extent of the potential problems under actual operating conditions and to implement mitigative measures. An intensive monitoring system is planned as part of the project. The system includes deep and shallow monitoring wells and lysimeters under selected drying basins for determining the quantity and quality of any leachate. If a problem is predicted as a result of the monitoring program, mitigative measures can be taken to prevent the potential problem from becoming a reality. The alternative mitigative measures could include lining or underdraining the basin, installing cutoff trenches down to bedrock, a system of shallow and deep wells, or some combination of these methods. A positive method of ground water pollution abatement can be	p i 3A(2)	Well water is found at varying depths in the site vicinity (See Issue II-1). EPA feels that positive protection via lining must be demonstrated as well as monitoring and emergency pumping procedures.

Continued next page

Letter #51, continued

devised once the extent of the problem is known. All of the alternative methods are costly, though some more so than others. The money used to implement any one or a combination of these methods could be wasted if it were included with the initial project construction and no serious problem actually existed.

In the EIS the EPA contends that lining the basins with pigmented bentonite is the only positive means of preventing leaching from the drying basin. We disagree. Because of the alternate wetting and drying cycles in the basin, the bentonite will crack allowing leakage.

Further, the EIS says that ground water pumping is not a positive way of preventing ground water pollution. We disagree with this statement. It has been our experience that ground water pumping can be an effective means of keeping undesirable materials out of the ground water.

p.i. 3.A.(3) This item indicates that an increased amount of water over that now consumed in the existing sludge disposal practices of Metro will be carried in the sludge, purge water and additional irrigation water to the Adams County site, reducing flows in the South Platte River downstream of the central plant. It is anticipated that at the maximum, purge water may amount to roughly 1.3 million gallons per day (MGD). With this purge water and sludge at 3 percent solids concentration, the total amount of waters sent out to the drying and distribution center would amount to less than 1 percent of the anticipated total plant discharge in 1985. This represents an insignificant 1.7 MGD at maximum.

EPA Response

p i 3A(3) This issue is discussed under Issue I-3 and reflects your latest data.

p.i. 3.A.(5) Concern is raised in this item that odors generated in the drying basins -- especially during digester upsets -- may be objectionable to the surrounding farmers and other residents. On numerous occasions we have indicated to the Region VIII Environmental Protection Agency office and to Engineering Science, Inc., preparers of the Environmental Impact Statement, that sludge from improperly operated or upset digesters would not go to the drying basins. This material would either be returned to the sludge digestion system or injected at the drying and distribution center, thus preventing any odor problem. With the 25 mile sludge transmission pipeline, approximately one day of time is available to take preventive measures at the drying and distribution center to keep the unwanted material out of the drying basins and divert it to the subsurface injection area. It is our opinion that this operational ability is sufficient to prevent odor problems at the drying and distribution center site from improperly digested sludge.

p i 3A(5) EPA experience is that there will be some odors from normal operation of this system. The emergency procedures for disposal of sour digester contents must also be followed. See Issue II-3.

Continued next page

Letter #51, continued

				EPA Response
p.ii.	3.A.(6)	It is indicated in this item that severe effects on soils, plants and ground water would occur if the site were to be used for a disposal area. This conclusion is questionable without any stated basis.	p ii 3A(6)	EPA agrees that the potential impacts are problematic; we are not willing to accept such potential degradation, however. Emergency disposal at Lowry is acceptable. See Issue II-15.
p.ii.	3.B.(1)	Heavy metals in crops have never been shown to be a hazard to humans even though there may be a possible hazard.	p ii 3B(1)	True. Impacts should be stated as potential.
p.ii.	3.B.(2)	EPA indicates that the longevity of certain parasites such as ascaris beyond the drying storage period comprises a public health hazard, especially in home gardens and city parks. There is no basis in fact on which to conclude that a public health hazard is associated with the use of sludge on home gardens and city parks (ref. page 113 and 143).	p ii 3B(2)	EPA has modified its position on park use, as long as Metro is willing to make the risks known to potential users. State regulations should also be able to control this problem. EPA still opposes use of sludge on home vegetable gardens. See Issues V-1, V-2, and V-4.
p.ii.	3.B.(3)	EPA indicates that water quality degradation from salt and nitrate movement below the root zone in home gardens, irrigated farms, city parks and sod farms is a long-term cumulative fact. It must be pointed out that the use of sludge presents less of a threat to the water quality than does the use of commercial fertilizers which are currently being used. One must realize that fertilizer is a necessity (ref. page 144).	p ii 3B(3)	EPA agrees that the potential threat is no greater than for commercial fertilizers if properly applied.
p.ii.	3.B.(4)	EPA indicates that air quality may be degraded by particulates and aerosols during severe wind storms, especially in dry farmed areas. It is inconceivable at the loading rates proposed for the dry land farmed areas that there could be any quantifiable degradation of air quality as a result of sludge particulates and aerosols during severe wind storms.	p ii 3B(4)	We agree that the hazard is very slight.
p.ii.	3.C.(1)	It has not been shown that heavy metals enter the food chain. It is possible that just the opposite is true.	p ii 3C(1)	Research has established beyond a doubt that certain plants and animals do concentrate heavy metals. See Issues I-1 and V-1.
p. 9		The first paragraph on this page indicates concern about the reliability of individual farmers adhering to recommended sludge application rates and quantities for a given piece of land and other required cultural practices. It is highly unlikely that farmers would overload their fields with detrimental levels of "sludge" fertilizer just as they would not do this with commercial fertilizer. Such action would be monetarily wasteful both in terms of production deterioration and the cost of the wasted fertilizer.	p 9	We agree that this possibility is low, although over-enthusiasm could be a problem.
p. 9		The last paragraph on this page indicates that the proposed alternative has a total capital cost of $25.9 million. It is difficult to derive this cost even if the digesters are included in this cost. The construction	p 9	The present worth cost should have been $24.0 million including the digesters, $17.7 million without including digesters (see Table 1, Volume I). These figures are estimates only so may differ slightly from estimates from other sources.

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Letter #51, continued

cost for the digesters is approximately $6,500,000, so the remaining cost for the solids recycling program would be $19,400,000 according to the information in this last paragraph. This amount is higher than the CH2M Hill estimate for the capital costs of implementing the solids reuse system, which is roughly $17,000,000.

EPA Response

p. 12 EPA indicates that subsequent complaints about odors forced Metro to modify its method of sludge disposal from landfilling to land spreading at Lowry. This statement is incorrect. It should state that subsequent complaints about odors led Metro to modify its method of operation from surface land spreading to land spreading and incorporation into the soil.

p 12 This statement has been corrected.

p. 12 In the last full paragraph near the bottom of the page it is indicated that Metro Denver adopted the recommendation of land disposal because of an environmental net benefit and the possibility of revenue from the sale of agricultural products. To our knowledge, the Metro District never adopted a land disposal system, but instead they adopted a solids recycling or beneficial reuse system. Also, the possibility of revenue from the sale of agricultural products was not a deciding factor in adopting the solids reuse system.

p 12 This statement has been corrected.

p. 17 "Alternative No. 16D, Vacuum Filtration - Pipeline Transport to Solid Waste Recycling Plant."

The final findings of the Denver Regional Council of Governments Resource Recovery Management Committee indicated that it would appear that this alternative, although showing much promise, will not be implemented for many years due to the poor economics associated with resource recovery and reuse of solid waste materials.

p 17 EPA has so stated in this EIS.

p. 18 EPA indicates that recent work on composting sludge shows great environmental and economic promise. This is a different picture than can be gleaned from the references relating to composting. Although it may have promise, there are certain distinct disadvantages with compost. Probably the major problem is the reduction in nitrogen concentration in the end product. Nitrogen content of compost is only about 1/3 of that which is in sewage sludge before composting.

p 18 The same nitrogen loss is evident in sludge drying (see Figure 13, Volume I of this EIS).

p. 23 The statement is made that EPA intends to evaluate whether the thermophilic range is desirable and within reasonable cost limits given the present design of the anaerobic digesters. There are many promising attributes to thermophilic digestion, however, there are also many problems associated with thermophilic digestion. It is suggested

p 23 EPA agrees and is willing to discuss the possibility of evaluating thermophilic digester operation.

Continued next page

			EPA Response
	that the Metro District and EPA enter into a joint effort to evaluate thermophilic digestion when the District's anaerobic digesters are in operation.		
p. 26	Figure 3 identifies the Metro Denver sludge drying and distribution site B-2 and the Lowry Bombing Range as well, however, the figure is incorrect. The location of the Lowry Bombing Range should be to the west of site B-2, rather than east of site B-2.	p 26	This figure has been corrected.
p. 28	In the paragraph at the top of the page it is indicated that the Lowry recycle site is closer to sod farms than is the selected site B-2. By scaling off the map provided in the Environmental Impact Statement, the sod farms are considerably farther away from the Lowry recycle site than is site B-2. For this reason, this statement in the EIS appears erroneous.	p 28	Distance-wise, the Lowry site is closer to some sod farms.
p. 28	Item 5 - The statement is made that a potential health risk may be associated with actual physical contact with the sludge. If this is so, wastewater treatment plant operators should not have one of the lowest incidences of disease normally associated with contact with domestic wastewater. It appears that EPA is doing little to eliminate the stigma surrounding recycling of domestic wastewater or sludge for beneficial purposes.	p 28	EPA must approach pathogen transfer from a public health standpoint that the risk is increased. Although no obvious increase in waterborn pathogen diseases has been noted with wastewater treatment plant workers, there is also very little hard research data on the subject.
p. 29	At the bottom of this page it is indicated that nitrate concentrations in the percolating water from the drying basins may be reduced by bacterial denitrification. It is further indicated that this process occurs under aerobic conditions. This is probably a typographical error, because denitrification occurs under anaerobic conditions.	p 29	This has been corrected.
p. 29	"Drying basin design alternatives." In this section it is indicated that deterioration of ground water quality may occur beneath the drying basins due to percolation of the liquid phase of the sludge into the ground water. Particular concern is associated with nitrate contamination of the ground water. The concern for ground water contamination is understandable, but the actual contamination may never occur, and if it did it probably would not occur for many years, perhaps more than 100 years, even if no mitigating measures were taken. Consequently, there is ample time to put the system in operation, monitor the percolation characteristics such as quality, rate of movement, etc., and then devise mitigating measures.	p 29	See discussion under Issue II-2.
p. 30	EPA indicates that the work being done at Greeley might be expanded to include studies of denitrification in the ponds. One must recognize that time is of the essence	p 30	EPA has waited until the Greeley test results were available. See Issues II-1 and II-2.

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Letter #51, continued

			EPA Response
	in this program, but the District certainly would be willing to cooperate further with EPA and look at denitrification at Greeley.		
p. 30	EPA indicates that they are interested in whether excess capacity will have an influence on secondary growth impacts and whether this capacity is excessive. They feel that it should be evaluated further. It is unrealistic to believe such excess capacity could have any effect on area growth.	p. 30	The EIS acknowledges this point in the second paragraph on p. 31. The draft Denver Regional EIS for Wastewater Facilities and the Clean Water Plan discusses the problem of growth in detail. The problem of present and future capacity is discussed from an engineering viewpoint in Issues II-12 and II-13.
p. 31	EPA states that the Metro District has indicated that no more than 180 hectares, 450 acres, of the proposed 240 hectares, 600 acres, drying and distribution storage area need to be developed immediately. Current District plans are to develop the entire 600 acres at this time due to the inflated costs associated with development of the area at a later date.	p 31	This will be reflected in the EIS.
p. 32	EPA indicates that although the proposed system appears most advantageous, some modified version of the existing system is the most likely option in the event the proposed system proves infeasible. Based on the alternative study, this statement is incorrect. If the present system were to prove infeasible, incineration would probably be the next most likely alternative.	p 32	This position of Metro has been noted.
p. 51	In response to the statement that "the proposed sludge reuse site, except for the irrigated farms in Weld County, are plotted on a geological map. In general, water bearing formations used intensively as a ground water source are less suitable for sludge disposal. Many other factors are important, however, the geologic character of an area cannot be the only criteria for site selection", it can be stated that the District will comply with all requirements and standards as established by the Department of Agriculture and the State Department of Health in regard to the distribution of its marketable product as a fertilizer, and would not attempt to select sites which should be included or excluded from sludge utilization.	p 51	We expect Metro to do so. See Issue V-4.
p. 68	EPA indicates that because of the potential for emission of odorous air contaminants from the drying distribution center, an emission permit from the Air Pollution Control Division of the Colorado Department of Health will be required. The Metro District will certainly acquire such a permit if it is required for the operation of the facilities.	p 68	Metro will be required to apply for an emission permit with the Colorado Air Pollution Control Division.
p. 72	EPA indicates that the representative irrigated farm also lies in an area which is devoted to farming activities. It is located approximately 0.8 kilometers (½ mile) east of Platteville, which is a small rural community. The farm lays 1.5 miles east of Platteville rather than 0.5 miles.	P 72	This has been corrected.

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		EPA Response	
p. 81	EPA indicates that the Denver Regional Council of Governments is the planning agency whose purpose is to coordinate plans of local and county governments and to ensure through the A95 review process that federally funded projects are in harmony with these coordinated plans. It infers that COG is presently studying the feasibility of coordinating a solid waste management program with Metro Denver sludge management system. This, however, is no longer the case, and the findings of the Solid Wastes Management Committee are that the coordination of programs is uneconomical at this time.	p 81	This has been amended in the EIS text.
p. 81	EPA indicates that the City and County of Denver uses a small portion of the Lowry Bombing Range for the disposal of its solids waste. Metro Denver Sewage Disposal District also uses this area on an interim basis for its sludge recycle operation. The Metropolitan Denver Sewage Disposal District does not use the City and County of Denver sanitary landfill area, but does use a portion of the land under ownership of the City and County of Denver.	p. 81	This has been noted in the EIS.
p. 84	Under the section entitled "Land Values," it is indicated that the present market value of the 2,000 acres of land under consideration for the drying and distribution center is $1 million. A CH2M Hill report entitled "Metro Denver District Sludge Management, Volume III Agricultural Reuse System Predesign" is indicated as the source of this market value amount. The subject report in no way indicated that the market value of the land was $1 million or $500 per acre. The value for the land indicated in the report was based on the assessed valuation of the property per the Adams County Tax Assessor's records. The assessed valuation was considered to be 33 percent of the market value, but even using this approach the market value seemed to be lower than reality. In some cases the land value would have been less than $50 per acre. Consequently, the consultants arbitrarily settled on $500 per acre as the cost of the land solely for the purpose of economic comparison of the three sites investigated in the report. The $500 per acre amount was used for each of the three sites.	p 84	This will be amended.
p. 89	The reference to Volume II Agricultural Reuse Predesign is incorrect. It should be Volume III Agricultural Reuse Predesign.	p 89	This has been corrected.
p. 93	Section entitled "Drying and Distribution Center Operation and Layout." The first paragraph under this section indicates that liquid sludge could also be distributed from the central plant and booster pump station. This mode of operation was discussed in the predesign report, but the ability to obtain liquid sludge at the booster pump station has been eliminated in an attempt to centralize the distribution of sludge at the drying and distribution center.	p 93	This has been corrected.

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Letter #51, continued

		EPA Response	
p. 93	In the last paragraph on this page at the bottom of this paragraph it is indicated that fences will be erected around the drying basins and stockpile area. Since this information was given to the preparers of the Environmental Impact Statement the design has changed, and fences will be provided around the entire solids drying and distribution center.	p 93	This has been corrected.
p. 96	First paragraph - The discussion of subsurface injection of sludge as a backup disposal method was essentially correct at the time the EIS was prepared, but the philosophy of operations of the solids reuse system has changed. The EIS indicates that up to 10 percent of the liquid sludge would be injected into the soil at high rates of 875 tons per hectare (390 tons per acre). It is now anticipated that sludge would only be injected if for some reason the liquid material were unacceptable for distribution to the public or for drying, or if the market for sludge reduced in the future. It appears at the present time that there could be an adequate market to use all of the Metro District sludge in 1985.	p 96	EPA will not permit disposal onsite except for emergency sour digester disposal and only at agronomic rates. See Issue II-15.
p. 96	In the middle of the paragraph it is indicated that a liquid sludge storage tank and a secondary effluent storage tank would be part of the on-site control complex at the solids drying and distribution center. Again, while at the time the EIS was prepared the need for liquid sludge and secondary effluent storage tanks was anticipated, they are no longer needed.	p. 96	This has been corrected.
p. 97	It is indicated that no definite contractual arrangements have been made for specific sludge recycling areas. It should be pointed out that the Metro District does not contemplate at this time entering into definite contractual arrangements for specific sludge recycling areas. Rather, it wishes to maintain a diversity in market which will provide the greatest opportunity for promotion of its products.	p 97	While we can understand Metro's desire to maintain a diversity of markets, the lack of any definable market areas has made it difficult to assess the impacts as well as the potential for overall success of this project. EPA will reluctantly approve this project, because it believes that even with the lack of a proven market, the energy efficiency and the ability of this project to make recyclable sludge available is sufficient to go ahead with the project.
p. 100	EPA indicates that an examination of characteristics of each sludge application site is necessary prior to embarking upon a sludge application program. Such examination should include analysis of soil (C.E.C.), pH and background heavy metals. This recommendation is feasible only when dealing with extremely large areas. However, when sludge is distributed to individual gardeners and home owners for use on extremely small plots of ground, this recommendation becomes inappropriate (as per the EPA Technical Bulletin on Municipal Sludge Management).	p 100	We agree that for small areas this may not be necessary. State guidelines should be followed on this point. (Issue V-4).
p. 102	Section entitled "Total Sludge Application Surface Rate Limitation." The EIS uses a zinc equivalent formula originally proposed in the reference 79 as indicated in	p 102	EPA has recognized the limited value of the zinc equivalent approach. Specific limits on heavy metals are more likely to be set, based on cation exchange capacities of soils (See discussion under Issues I-1 and V-1).

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Letter #51, continued

EPA Response

	this section. The EPA advocated the use of the zinc equivalent to determine the total amount of sludge that could be applied to a given parcel of land in their technical bulletin entitled "Technical Bulletin Municipal Sludge Management Environmental Factors," July 1975. On June 3, 1976, the EPA proposed revised guidelines that no longer rely on the zinc equivalent. Even though there is much controversy surrounding the validity of the use of the zinc equivalent equation, application of this equation in the EIS indicates that the Metro sludge can be applied to land for an extended period of time without detrimental effects from heavy metals.		
p. 105 and 106	In the discussion of sludge recycling at Lowry Bombing Range, there are several incorrect statements. EPA indicates that contour strips are loaded to a maximum of 175 tons per acre and then the operation moves on to a new tract. This is not correct. Thirty tons of sludge are applied annually to each acre of land at the Lowry Bombing Range. There are no additional tracts to use. The 175 tons per acre figure is now 205 tons per acre. Next year it will be 235 tons per acre. EPA also indicates that during the winter months when land application becomes impeded by ice and snow on the ground, the land spreading operation is temporarily replaced by direct dumping of sludge into pits in a manner similar to solid waste landfilling. This is not correct. Sludge is dumped directly onto the surface of the soil and intermixed with dirt at five parts of dirt to one part of sludge. No pockets of sludge are allowed to accumulate in the Lowry operation.	p 105,6	This loading rate on Lowry has been corrected. The winter operation has been amended in the text.
p. 107	EPA indicates that if the proposed sludge recycling plan is somehow aborted and if Metro Denver is also barred from land spreading at the Lowry Bombing Range, it is possible that sanitary landfilling would be the reasonable alternative. Based upon the alternative study, the next best alternative would be incineration.	p 107	This sentence now reflects Metro's position.
p. 109 and 111	EPA indicates in the paragraph on soil that the excavation of the 240 hectares, or 600 acres, of land to five feet depth for the drying basins would effectively disturb all of the soil in a large area, and thus an irretrievable loss of the soil resource from the site would occur. Sludge has long been noted for its ability to develop soils in waste areas, strip mines, etc. Therefore, through the use of sludge on this area, the soil resource would not be irretrievably lost.	p 109, 111	Effectively, the soil capacity would be lost for at least the life of the project. Given the disruption of the subsoil layers, it is difficult to predict whether the soil could be returned to its former capcity.

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Letter #51, continued

		EPA Response	
p. 111	EPA indicates that monitoring of leachate water quality and movement rates will be necessary whether or not basins are lined. The District currently anticipates a comprehensive joint ground water monitoring program with the U.S. Geological Survey at the 2,000 acre site; a comprehensive program similar to the one which has recently been completed at the Lowry Bombing Range. It is the intent of this joint effort to begin monitoring of ground water quality prior to the implementing of the drying/distribution facilities operation, and to continue to monitor the effect which this system operation will have on ground water quality in the area. EPA further states that the rate of movement would be slow; it would take 20 to 100 years for the water from the basins to reach the ground water table.	p 111	This is still EPA's position, that monitoring will be required, along with lining of the basins. The soil permeabilities have been modified based on data from the Geotechnical Report (Issues II-1 and II-2).
p. 116	EPA indicates that public access to the drying beds should be curtailed while the sludge is drying and special periodic medical examinations and preventive treatment by qualified physicians should be made available to project personnel and consumers who come to the site to collect sludge. The Metro District has been in operation for 10 years and literally hundreds of its employees have been in direct contact with raw sludges, both primary and secondary, and there has not been a reported case of disease being transmitted as a result of their exposure. Recognizing further that the anaerobic digestion of sludge is known to be an effective means of destroying pathogen and other organisms in raw sludge, it would appear that such a recommendation would be unnecessary.	p 116	Metro, however, does plan to fence the entire site; admittedly, there are no documented cases of disease transmission from this operation.
p. 116	Second paragraph - There is a statement in this paragraph that indicates that the run-off impoundments will be 50 feet above the water table. Field investigations indicated that the ground water table is more than 100 feet below the surface. Therefore, the impoundments will be more than 100 feet above the water table.	p 116	This has been changed; also it is expressed in terms of the existing water table, since the table could be modified radically after Metro operation.
p. 119	EPA states that an emission permit is required from the Air Pollution Control Division of the Colorado Department of Health under regulation No. 2 promulgated by the Colorado Air Pollution Control Commission. Included in this permit would be a definite plan for the control of odor emissions. In addition, a complete inventory of quantities and rates of emission is required for all odorous compounds being emitted from the site. Based upon the experience of the District in the utilization of anaerobically digested sludge, there has not been any problem with odors as a result of anaerobically digested sludge.	p 119	The Air Pollution Control Division will have to assess the odor potential from this type of operation in their permit process.
p. 120	Paragraph 4 - The last sentence in this paragraph states that during digester malfunctions severe odor problems	p 120	This has been corrected.

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			EPA Response
	may be expected at the drying and distribution center if sludge were to be pumped to the site. Little or no odor problems would occur at the site even if sour sludge were pumped to the site under such conditions because the sludge would be directly incorporated and would not be exposed to the atmosphere.		
p. 128	EPA indicates that unpaved sections of roadway on Weld County Road 30, for example, can lead to dust problems under conditions of heavy traffic. Because many areas in which deliveries will occur are under jurisdiction of an air pollution control district, Colorado's fugitive dust law will apply, requiring a dust abatement plan to be filed prior to the start of deliveries over unpaved roads (ref. 104).	p 128	We are not sure whether this means Metro will have to do the dust abating on unpaved roads or not.
p. 136	Figure 16 - This comment is general for the whole EIS, not only specific to Figure 16. It appears as though EPA is placing far too much significance on negative impacts to ground water quality due to leaching from the drying basins. With many years before the leachate will reach the ground water, if ever, and with little or no information of the possible effects on the ground water due to the leachate, the impact placed on this item in the EIS seems out of balance with the potential benefit to be received from the solids reuse project and the negative impacts of not proceeding with the project.	p 136	We have taken pains to point out that this display of impacts cannot be summated; the number of negative impacts tends to outweigh the positive ones because the National Environmental Policy Act requires a closer look at adverse impacts than positive ones. Each negative impact is singled out for discussion. Its importance can vary from an intense but small area impact (such as site soil loss) to one of potential broad impact (such as the benefits of recycling sludge nutrients). Therefore it is not intended as an overall evaluation, simply a display for rating the importance of each impact discussed. Mitigation can also play a role in reducing some of the negative aspects.
p. 138	Figure 17 - Both this figure and Figure 16 contain ambiguity. For example, in Figure 17 under the impact parameter "aesthetics" it is indicated that there will be a low negative impact if sludge is to be used on city parks, however, there will be a high beneficial impact on aesthetics if the sludge is used on a mine spoil site. Presumably, the reason for the high beneficial impact for the mine spoil site is the result of the lush vegetation that would be grown on the mine spoils. Obviously, use of sludge on city parks will result in lush vegetation in the city parks. This, therefore, should also be a beneficial impact. This same comment applies to the use of sludge on home ornamental gardens or edible plants.	p 138	There is a problem here of the subjectivity of the observer in assessing impacts on aesthetics. Actually a more realistic rating might say that the effect of sludge applications on parks runs the gamut of a very negative impact on some persons who object to the public use of sludge to a highly positive impact as a result of the ornamentals grown. In any case, we rate the importance of the impact only as "low". Incidentally, these Summary Comparison figures have been updated to reflect EPA's latest appraisal.
p. 141	The first sentence of the last paragraph is misleading. It tends to indicate that concentrations of Cd are greater than Cu or Zn, which is not true.	p 141	This has been amended.
p. 141	The sentence that refers to 1 percent of Cd to Zn concentration is misleading. There is recent evidence that would indicate that Zn does not affect Cd uptake into plant tissues.	p 141	See discussions under Issues I-1 and V-1.

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Letter #51, continued

			EPA Response
p. 143	EPA makes the statement that if sludge is used to fertilize crops or home garden vegetables, which will be eaten raw within the first year of application, adverse health impacts will result. It should be pointed out that for many years individuals have been utilizing anaerobically digested sewage sludge on vegetables to be eaten raw and no adverse impact has resulted. This statement would more appropriately read ... "if sludge is used to fertilize crops or home garden vegetables, which will be eaten raw within the first year of application, adverse health impacts may result" (ref. page 14	p 143	This has been amended.
p. 144	EPA indicates that if a two-year drying period is instituted it will ensure that no significant impacts will result from park application of sludge. This safety measure will be necessary because particles of sludge will probably be ingested by some picnickers and children playing in the dirt, etc. The two-year drying period is inconsistent with statments made on page 113. EPA indicates that long-term storage of sludge is an effective reducer of pathogenic organisms (ref. 82). Storage of liquid digested sludge for sixty days at 20°C (68°F) or 120 days at 4°C (40°F) has been reported to be a successful pathogen reduction measure (ref. 79). Based on this statement, the two-year storage time for pathogen destruction is excessive. (Also read page 143, Public Health.)	p 144	Although the methods on page 113 are stated to be effective pathogen reducing mechanisms, they are no guarantee against survival of the organisms like Ascaris that can survive for longer periods. We believe that general approach suggested at the end of the discussion on Pathogens on page 144 is still valid: ".. as the level of human contact becomes more probable for each use (dry farms, irrigated farms, home gardens, vegetable crops, in increasing order), required length of storage time in the drying and stockpile areas should be increased." EPA recommendations for pathogen control are found in the discussion under V-1, V-4, and Appendix A of this document.
p. 144	EPA states that potential pollution of groundwater will not pose a significant health hazard. The primary chemical constituent of concern is nitrate. Nitrate levels of 45 parts per million measured as nitrate in drinking water are considered to be harmful to infants (ref. 112). However, as indicated below under "Water Quality", groundwater contamination under most land recycling schemes would be less than, or the same as, from the use of commercial fertilizer. This statement could also be appropriate for all other consideration of nitrate pollution of the ground water where sludge is used in the place of commercial fertilizer.	p 144	We agree.
p. 145	Last paragraph - It is indicated in this paragraph that application of sludge to city parks will result in nitrate leaching to the ground water in about 20 to 100 years. Further, it is stated that this leaching rate may be increased because of past applications of commercial fertilizers which presumably are high in nitrates. Concern with nitrate leaching to the ground water due to sludge application is puzzling, especially when admittedly commercial fertilizers that are higher in nitrates than sludge are also potentially causing groundwater pollution problems and yet little is done to curtail the use of commercial fertilizers for this same reason.	p 145	We agree.

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		EPA Response	
p. 147	EPA indicates that as large numbers of home owners and gardeners adopt sludge amended practices, water pollution hazards on a large scale will be inevitable. Ornamental plants and vegetables are both typically heavily irrigated and often over irrigated, causing both deep seepage into the ground water reservoir and run-off toward surface streams on a regular basis. Opportunities for improperly high application rates and consequent degradation of water supplies are thus abundant in this type of recycling of sludge. In this case, EPA's statement should indicate that ground water contamination under most land recycling schemes would be less than or the same as from the use of commercial fertilizers. Another appropriate factor is that small quantities of this valuable resource would be distributed over many acres within the urban community, thus reducing the total impact of ground water and surface water contamination.	p 147	This has been modified.
p. 166	This page discussed the impacts of subsurface injection of liquid sludge at the drying and distribution center. When the project was initially conceived, a 60-acre subsurface injection area was to be used for that period of time until a sludge market could be developed. It was not felt, however, that this 60 acres could be used for long-term use for disposal of the sludge. Because a significant market for the sludge has developed in the past year, the present concept is not to use this area as a disposal area, but more of a research demonstration area similar to the rest of the buffer area surrounding the drying basins.	p 166	EPA will not permit the use of the B-2 site as a "disposal" area. Agronomic rates must be met for sludge injection.
p. 167	EPA indicates that the disposal of sludge to the Lowry Bombing Range represents the no-action alternative and would be continued if agricultural reuse of sludge is not implemented. Once again, reference should be made to the alternative study; if beneficial reuse concept is not adopted, incineration would be the next best alternative.	p 167	EPA would at this time recommend some form of sludge recycling centering around the Lowry site, if the Metro proposal should falter. We do recognize that Metro's position is that they favor incineration as a project alternative. EPA does not feel that a resolution of this difference of opinion is necessary at this time.
p. 170	EPA states the organic matter contents of the soil will rise to about 1.75% in the top 15 centimeters (6") of the soil at the current 400 metric tons per hectare (175 tons per acre) total loadings. It should be pointed out that the total loadings to the Lowry site currently exceed 175 tons per acre. Each acre of the available land at Lowry is loaded at 30 dry tons per acre per year, and will continue to be loaded at that rate each year until the new system is implemented.	p 170	This has been noted. Metro's present operation at the 240 ha [600 acres] Lowry site should be characterized as a disposal system, not a beneficial recycling system, since the land is dedicated for the use of sludge disposal (as agreed to by the City of Denver) and eventually as a landfill. Therefore loading rates of sludge are not limited by agronomic factors.
p. 171	EPA indicates that the preliminary raw data from the surface water analysis at Lowry are still not enough to help set actual impacts. It can be summarized from the trends	p 171	We would agree with this general assessment of pollution at the Lowry site. See the discussion on Issue III-1.

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Letter #51, continued			EPA Response
	that nitrate/nitrogen is already finding its way into the surface water and the shallower ground water reservoirs. Based on the information which the District has currently concerning the ground water project, there is insignificant ground water pollution at Lowry. Catch basins are subject to run-off, however, cattle wade and defecate into these basins which accounts for the high nitrate content.		
p. 172	Chaney's more recent work shows that zinc does not limit cadmium uptake.	p 172	This consideration has been reflected in the final EIS and is discussed in Issue V-1.
P. 175	EPA indicates that under the present operations at Lowry with largely undigested sludge, odors are easily perceived at close proximity to the application areas, especially when digester problems are encountered. The last part of this statement reads incorrectly because the District encounters no digester problems with no digesters in operation.	p 175	This has been changed.
p. 176	EPA indicates that should the project not be implemented, truck traffic to and from the Metro Denver central plant facility and the Lowry Bombing Range will continue at a rate of 35-40 truck trips per day until such time that the land can no longer accommodate additional increments of heavy metals associated with the Metro Denver sewage sludge. Theoretically, the Lowry site is designated as a solids waste landfill, and the soil could thus accommodate heavy metals for eternity, however, there would be no production of vegetation on this site.	p. 176	EPA agrees.
p. 177	Cadmium is not the most mobile of heavy metals.	p. 177	Cadmium is one of the more mobile heavy metals.
p. 181	EPA indicates that lining the bottom and the sides of basins with impermeable materials is the only fully effective way to mitigate nitrate and other salt accumulations in the ground water. This has not been substantiated as mentioned previously.	p 181	The wording has been changed; however, the basic position that lining is necessary is not changed.
p. 182	Section entitled "Surface Water Pollution From Experimental Plots." This item need not be listed here as a negative impact with recommended mitigative measures. As mentioned previously in the EIS, surface water will be impounded and tested to ensure safety from a public health standpoint prior to release to natural drainage-ways. Listing of this item here gives the impression that in the proposed solids reuse system there is no provision for run-off collection and pollution abatement to surface waters.	p 182	This has been corrected.
p. 182	EPA indicated that a qualified entomologist should be retained at the early stage of the full utilization of the drying basins to identify species of insects colonizing the basins and control measures defined through the	p 182	It is important that the Metro District does develop an adequate plan to minimize insect and rodent vectors on the B-2 site. EPA will insist that Metro report the development of such an insect control plan before construction approval is given.

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			EPA Response
	identification process should be implemented. This expertise should be provided for during the early stages and the full utilization of the drying basin. Over the past several years the Metro District has utilized the Colorado State Health Department's Vector Control Division, specifically Mr. Ted Davis, to assist with all vector problems. In discussions with Mr. Davis, he indicated that he would be willing to assist during the initial stages of the operation.		
p. 183	Section entitled "Land Application in Sludge Recycling Areas." It is recommended in this section that the most important overall mitigative measure for negative impacts of land application of sludge would be to limit the land application, in the initial years, to sites with the least area of adverse impacts. Such sites would include mine spoil sites and sod farms. It appears that with this philosophy the District's solids reuse system may be forced into a self-destruct situation. Unless many mining companies other than Climax Molybdenum were to undertake mine tailings reclamation and unless more sod farms were to be established in the Metro Denver area, the District would have a difficult time marketing the sludge. By suggesting that application to irrigated farms be limited during the initial years of the project a considerable potential market for the sludge would be eliminated.	p 183	EPA will continue to encourage the District to proceed in this manner.
p. 183	EPA indicates that removal or reduction of sources contributing heavy metals to the wastewater management system will mitigate many of the adverse impacts on soils, plants, animals and the food chain. This can be done by promulgation of a special wastewater ordinance setting tolerable limits on concentrations of various substances entering the sewer system, thus forcing industries to adopt inplant measures to curb discharge of heavy metals. Regulations now exist within the District Act to control toxic substances which could effect the end use of sewage sludge.	p 183	EPA does not now encourage this form of control in the Metro situation, where other factors such as soil pH predominate.
p. 183	EPA indicates that control of the cadmium/zinc ratio is another important mitigating measure. If this ratio is kept below 1%, acceptability of the sludge for use on feed crops and foods will be greatly enhanced through the plant yield reduction affected by zinc long before either element accumulates in toxic concentration. The problem with the Metro District sludge is that it is low in metals as reported in the body of the EIS. The only realistic approach perhaps to resolve this problem is to add additional zinc to the sludge prior to application. The Cd/Zn ratio is ineffective. Zn does not affect Cd uptake into plants.	p 183	EPA does not encourage the use of the Cd/Zn as the management control method in light of recent research findings. The management procedures with respect to heavy metals is discussed in Issues I-1 and V-1.

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Letter #51, continued

			EPA Response
p. 184	EPA indicates that record keeping, inspection of sludge application operations on individual sites and monitoring of environmental parameters are functions which must be carried out by the District or another responsible agency, and close cooperation with individual farmers and operators. These functions will prevent inadvertant aggravation of impacts by excessive non-uniform or careless application of sludge and will mitigate the adverse impacts. It may be necessary to obtain binding agreements with recipients of sludge to permit inspection and monitoring and to provide for cessation of sludge supply in case of noncompliance with recommended management practices. It should be pointed out that the farmer today is a highly technically competent person. It is inconceivable that farmers would haphazardly apply sludge to their land as it is inconceivable that farmers would haphazardly apply other types of commercial fertilizers. The cost impacts are of such significance today that this situation will mitigate itself.	p 184	Metro should, however, provide guidance to farmers by recommending rates and proper management techniques. Although most of today's farmers are quite sophisticated, the District should not expect the farmer to have full knowledge of all the parameters involved in proper sludge management. The record-keeping and inspection functions provided by the District should also serve as an educational process on the benefits and limitations of sludge use for sludge users.
p. 184	As stated in previous sections, the soil should be maintained at a minimum pH of 6.5. Calcium in itself does not affect heavy metal uptake. Where necessary, mitigative measures should be used to raise the soil pH where it is below 6.5.	p 184	This has been corrected. It is the carbonate, not the calcium that affects heavy metal availability through control of pH.
p. 184	Although heavy metals from plant materials do accumulate in kidneys and livers of animals, there has been no documented case where concentrations of these metals reached a level which would be harmful to humans. Metro studies would tend to indicate that older animals having never been exposed to sludge have higher levels of heavy metals in kidney and liver than younger animals fed sludge directly. Without any evidence or data of any sort, it is improper to make this kind of recommendation.	p 184	This recommendation lies in the area of possibility, should research so indicate a concentrating effect in livestock livers and kidneys to levels considered harmful to humans.
p. 185	Section entitled "Nitrate Pollution of Ground Water, Especially in Irrigated Farms, Sod Farms, Home Gardens, City Parks." This section indicates that the preparers of the EIS feel that a potential user of the sludge would be careless or wasteful in the use of this material. Most users, particularly farmers, would likely be judicious in the use of sludge as a fertilizer just as they are with commercially available synthetic fertilizers. Over application of this material would not only be wasteful of the material itself, but also costly to the farmer. Consequently, it is doubtful that the individual farm user would inadvertently apply this material in heavy concentrations.	p 185	We are somewhat concerned about overzealous use of the material. The philosophy, "if a little bit is good, a lot must be better", would not work in this situation. We can agree, however, that most farmers would be mostly concerned about keeping operating costs down, and hence avoid overuse.
p. 185	EPA indicates in the section on nitrate pollution and eutrophication of lakes and other water bodies that the use of liquid sludge injectors applying sludge at greater	p 185	We have deleted this recommendation, although in specific cases, it might still apply. If sludge were to be used in proximity to a lake or stream, and no tailwater control on the land were practiced, a judicious use of sludge injection would probably be preferred over dried sludge. We agree that the potential for groundwater contamination might be somewhat greater with this approach, particularly if the sludge were injected below the plant root zone.

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	Letter #51, continued		EPA Response
	depth should be preferred over application of dried sludge. The District recognized the potential for liquid sludge, however, it believes that the most acceptable method for applying sludge to land is in the dried form. Care must be used with liquid sludge injectors sludge is not injected at a depth where the nutrients are not readily available to the plants. In this case, nitrogen movement downward would not be available for growing, and therefore, a waste of the valuable resource.		
p. 185	Section entitled "Exposure of Humans to Viable Pathogens and Parasites." This section suggests that sludge should be air dried for at least two years prior to use in land application operations in order to reduce the numbers of viable pathogens. Later on in this statement, it suggests that an alternative method of pathogen reduction is to store liquid sludge for 60 days at 20°C or 120 days at 4°C. It seems that if storage of liquid sludge for 120 days at 4°C is adequate to reduce the numbers of viable pathogens then storage of dried sludge for two years is far too conservative.	p. 185	The two year period mentioned includes both drying and storage time, and is intended for the most sensitive use in terms of public health, namely individual home garden use. For all others uses where human contact is much less, a one-year drying and storage time is adequate.
p. 186	EPA indicates that current research shows preliminary promise in the use of high energy electrons for disinfection of sludge passing in a thin stream in a specially adapted process. The feasibility of use of these and other means of pathogen destruction should be continually considered for application and use. The Metro District is currently following the innovative technologies which are being developed in the industry, however, after recent communications with the manufacturers of high energy electrons disinfection devices it does not appear to be economically feasible at this time.	p. 186	EPA agrees that this method of disinfection is not feasible at present.
p. 187	EPA has indicated that in the initial toxicity of liquid sludge to seeds and young plants, the use of special injectors applying the material in separate bands deep into the soil will help in the mitigation of toxicity to seed and young plants. One should caution about the deep incorporation approach; sludge applied too deeply in the soil will not provide the nutrients to support the plant's growth.	p 187	This has been amended.
p. 187	The paragraph on heavy metals accumulation in soils, plants, animals, and food chain is difficult to understand.	p 187	This has been changed.
p. 188	The second paragraph on initial toxicity of liquid sludge to seed and young plants is redundant, the same subject is covered on page 187.	p 188	True.
p. 192	Section entitled "Destruction of Wildlife Habitat." It is suggested in this section that most of the 2,000 acre drying and distribution site would be irretrievably lost	p 192	EPA would like to discuss with Metro the proposed status for the "relictual prairie" area identified in the facility plan environmental assessment. Perhaps Metro could create a more productive wildlife area through use of sludge application.

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Letter #51, continued

			EPA Response
	as a wildlife habitat. Because of the intense farming operations presently in effect at the site of the drying and distribution center, it is likely that the wildlife habitat has already been destroyed or at least greatly disturbed.		
p. 192	Salt accumulations from the utilization of sludges should be no worse than those effects from using commercial fertilizers or manure from cattle. If agricultural production is to remain at its present level or increase, salts (which are plant nutrients) will have to be added to the soil, thus, the accumulation of salts will occur regardless of the use of sludge.	p 192	It is true that most solid fertilizers are applied through the use of ionic species [e.g. $(NH_4)_2SO_4$, $NaNO_3$, $Ca_3 (PO_4)_2$] and that use of the nutrient species still leaves the ionic residues in the soil. The chief issue is whether sludge contains excess salts that have no nutrient value. This issue is discussed under Issue V-1.
p. 193	No danger or hazard has been demonstrated. In fact, where studies have been conducted (notably Australia) where cattle are exposed to raw untreated sewage, the animals have shown no disease problems or accumulations of heavy metals. At the present time these dangers are speculative, not confirmed.	p 193	EPA still feels that this practice represents a potential hazard, as does the FDA (see Letter #37) and the Colorado Department of Agriculture (see Letter #24).
p. 194	Soil profiles will be obliterated, but the insinuation that those soils will permanently lose their agricultural characteristics is erroneous.	p 194	EPA maintains that soil productivity will be lost and that reclamation of the soil profile to its present state is problematic.
p. 194	The assumption that unlined basins or fields where sludge is used will lead to contaminated ground water is not necessarily true. Most of the South Platte River basin and indeed much of the ground water in agricultural areas of Colorado is already polluted to a greater extent than leachate from the drying basins, or sludged fields, where sludge is applied properly. It is necessary to make an assessment of the ground water quality in a given region before stating categorically that ground water pollution will occur.	p 194	EPA agrees that sludge applications on fields in agronomic amounts poses no greater threat than commercial fertilizers. The drying basins however, will be receiving 1900 to 3800 m3/day [.5 to 1 mgd] of nutrient and salt laden materials.
p. 195	Soils are dynamic environments which maintain equilibrium with many solution and solid phases (particularly where metals are concerned). The assumption that soils will be a repository for heavy metals is true, but to conclude that this is an adverse effect is false.	p. 195	The discussion referred to here was merely pointing out some of the adverse effects which may occur with long-term use of sludge. Addition of heavy metals in quantities higher than soils can tolerate is an adverse impact. Monitoring sludge amended soils for metals at five year intervals will detect increasing concentrations soon enough to cease sludge application before the metals reach unacceptable levels.
p. 196	Iron is never toxic to plants, at least in a soil environment.	p. 196	EPA agrees that iron will not present any problem for sludge application.

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This section presents the detailed discussions of the important issues raised by the letters and comments received during the review of the draft EIS. The issues are broken down into five categories, namely (1) pipeline and plant issues; (2) site-specific issues; (3) continuation of the present operation; (4) alternatives; and (5) constraints to sludge use offsite. Each of the various issues are discussed under the appropriate category. Where an issue is also addressed in Volume I, a reference is made to the section in which it may be found in that volume.

SECTION C

DETAILED ISSUES DISCUSSIONS

ISSUE I

PLANT OPERATION AND PIPELINE IMPACTS

ISSUE I-1. What kind of source control at the Metro Plant is needed to limit concentrations of heavy metals and persistent organics such as polychlorinated biphenyls (PCB's) and pesticides for sludge applications to land?

This issue was raised by EPA in the draft EIS and subsequently by many others. In order to gain a perspective on the issue, it is first necessary to look at the problem of heavy metals and persistent organics. What are the present concentrations in sludge, and what levels of various metals are considered hazardous? Finally, what is Metro and EPA doing to control the levels of these sludge contaminants?

Heavy-metal buildup in the soils and its concentration in the food chain is a major concern in the use of sludge on cropland. This problem has received much attention recently as it presents one of the major potential hazards in the use of sludge on soils. EPA recently released an appraisal of the problem written by a task force of experts in the field (the CAST study, Reference 38). A study of the soils in the area, and a test of the impact of Denver liquid sludge applied to wheat grown at the Watkins Test Site in Adams County have been carried out (References 2 and 3). This information allows an appraisal of the potential hazards expected to be encountered with the application of dried sludge to crop land, which is discussed in more detail in Issue V-1.

Metro routinely analyzes its sludge for Manganese (Mn), Zinc (Zn), Copper (Cu), Nickel (Ni), Cadmium (Cd), and Lead (Pb). The average heavy metal content of Denver sludge determined by Metro for the year 1975 is presented in Table 1. In addition, the results for Metro Denver sludge of an analysis carried out in 1972-1973 on sludges from 16 American cities are also presented for comparison (Reference 4). All of these metals have been identified as posing a potentially serious hazard to plants or animals except Mn (Reference 5). In addition, the concentrations of Molybdenum (Mo), Arsenic (As), Mercury (Hg), and Selenium (Se) were analyzed in Denver Northside anaerobically digested primary sludge. These concentrations, as well as those reported in Reference 4 for Metro's sludge, are presented in Table 2 and represent the average from two to three different grab samples.

Table 1. AVERAGE HEAVY METAL CONTENT OF METRO DENVER SEWAGE SLUDGE FOR THE YEAR 1975

Sludge Type	mg/kg Dry Weight					
	Mn	Zn	Cu	Ni	Cd	Pb
Polymer treated anaerobically digested primary sludge.[1]	186±69	1140±350	978±245	260±90	23±7.5	600±97
85% Waste activated & 15% Raw primary treated with $FeCl_3$+lime[1]	277±61	1075±196	740±204	192±48	19±6.9	312±68
Waste activated treated with $FeCl_3$+lime[2]	224	2860	1370	562	46.1	1011

[1] Source:. MDSDD #1.

[2] Source: Reference 4. The exact source of sludge in this study was not given. A single sample was provided by MDSDD #1 from its central plant and is presumably similar to the waste-activated/primary mixture above.

Table 2. HEAVY METALS CONTENT OF ANAEROBICALLY DIGESTED SEWAGE SLUDGE

Element	mg/kg Dry Weight	
	Northside Primary Sludge[1]	Metro Waste-Activated Sludge[2]
As	1.3	14
Hg	11	3.6
Mo	40	18.1
Se	5	3.5

[1] Source: MDSDD #1.

[2] Source: Reference 4.

A comparison of the values presented by Metro with those presented in Reference 4 show discrepancies in several metal concentrations. In particular, the values for Zn, Cd, Pb, and Ni reported in Reference 4 are over twice as high as those reported by Metro. However, the analyses in Reference 4 were performed in 1972-73; Metro's values are for 1976. It would appear that the levels of trace metals in Metro's sludge are decreasing.

The State of Colorado draft regulations on limits for heavy metal concentrations in sludge applied to the land are presented in Table 3. Sludges having metals within these ranges would be considered acceptable. The draft guidelines do not have criteria for metals other than those in Table 3.

Table 3. PROPOSED RANGES OF TRACE ELEMENT CONCENTRATIONS IN SLUDGES APPLIED TO LAND IN THE STATE OF COLORADO

Element		Range, mg/kg
Zinc	(Zn)	500-3000
Copper	(Cu)	230-1500
Lead	(Pb)	100-1500
Nickel	(Ni)	25-1000
Cadmium	(Cd)	5-30

Source: Reference 5

A comparison of the values in Table 3 with those reported by Metro in Table 1 shows that Metro's sludge falls within the recommended limits. If these limits are adopted and Metro's sludge continued to show the same or lower metal content, then no further mitigative actions need be taken.

The U. S. Food and Drug Administration recently adopted recommendations for sludge use on land (Reference 6). The FDA recommends that sludge applied to land used to grow human and animal food not contain more than 20 ppm Cd, 1000 ppm Pb, or 10 ppm PCB's on a dry basis. Metro's sludge has slightly more Cd and less Pb and PCB's than recommended by the FDA.

A source control program will be conducted by MDSDD #1 to reduce the quantity of metals discharged to the sewage system. A survey is now beginning to ascertain which industries are discharging excessive quantities of metals to the system, and these industries will be required to pretreat their effluent to remove as much of these metals as possible. In this way, the metal content of the sewage and sludge will be reduced to as low a value as practical. The U.S. Department of Agriculture has recommended source control to reduce the heavy metal content of wastewater sludges (Reference 7).

Until the state has adopted final regulations for sludge used on land, Metro will be required to stockpile its sludge. These guidelines should be adopted before Metro is ready to begin disbursing sludge to consumers, since sludge will require a year to dry and a year of stockpile before release in any case. The public health, plant, soils and long-term effects of metals in sludge applied to land are assessed in Issue V-1.

Table 4 presents the concentrations of various pesticides, herbicides and PCB's found in a one month composite sample of Metro sludge. No guidelines have been issued to date by any agencies on tolerable levels of pesticides or herbicides; however, the concentrations found should pose no problem for sludge applied to land.

PCB's are reported in Table 4 as AR-1254. Other types of PCB's were not specifically determined, but are reported as AR-1254. Therefore, this value is representative of the total PCB concentration in this sample of Denver sludge (Reference 8).

The 1977 amendments to the Clean Water Act considerably strengthen the requirements for pretreatment of industrial wastes entering municipal treatment systems. Under these amendments, EPA will have to establish national pretreatment standards for toxic pollutants. Industrial discharges will be required to reduce these toxic pollutants using the "best available treatment economically achievable". Higher concentrations of toxic pollutants discharged to a municipal treatment plant would be allowed only if it can be demonstrated that such concentrations would not violate effluent standards if discharged directly by the industry, and that they would not prevent proper sludge use. Congress has thus created a mechanism that should reduce the heavy metals and other toxic substances in sludge thereby improving its quality for agricultural use.

Sewage treatment plants like Metro's will be required to have their National Pollutant Discharge Elimination System (NPDES) permits amended to identify sources and amounts of industrial pollutants entering their plants. These industries will have to comply with the pretreatment standards. Loans from the Small Business Administration will be made

Table 4. CONCENTRATION OF ORGANIC RESIDUES IN METRO DENVER SEWAGE SLUDGE
(all values in ppb, dry weight basis)

Compound	Anaerobically Digested Treated with Polymer	Waste Activated plus Primary Treated With $FeCl_3$ and Lime
P, P' -DDT	T*	202
P,P' -DDE	300	94
P,P' -DDD	497	65
P,P' -BHC	16	20
Dieldrin	86	35
Hexachlorobenzene	NF**	4.9
Chlordane	1535	636
AR-1254	4252	751
O,P' -DDT	NF	NF
O,P' -DDE	NF	NF
Beta-BHC	NF	NF
Heptaclor	NF	NF
Endrin	NF	NF
Lindane	NF	NF
Heptachlor Expoxide	NF	NF
Oxychlordane	NF	NF
Mirex	NF	NF
trans-Nonachlor	NF	NF
Aldrin	NF	NF
Methoxychlor	NF	NF

* - Trace

** - Not Found

available to industries to help with pretreatment costs.

EPA has already begun requiring removal of known hazardous substances from industrial operations entering municipal treatment plants. For example, EPA recently published Pretreatment Standards for Electroplating Industries (Reference 9).

As the regulations under this act are developed, specific pretreatment limits will be set for Metro. Metro will be required to submit a pre-survey report to EPA within a year identifying sources and likely reductions available with added pretreatment (see Appendix A).

Issue I-2. Please provide a better description of the proposed pipeline, routing, existing conditions and impacts along the pipeline right-of-way.

EPA was severely criticized in the draft EIS for a lack of specific information on this issue. This section describes in more detail the pipeline route, which is shown in Figure 1. Wherever possible the route has been chosen to stay within established road right-of-ways or to cross previously disturbed land. The route is as follows: the line crosses the Metro plant site and goes through an adjacent greenhouse/agricultural area. It passes beneath the Burlington Ditch, following the right-of-way of the existing Sand Creek sewers, then follows the east bank of the Burlington Ditch to 64th Avenue. The line goes eastward along 64th Avenue to Colorado Boulevard, and follows the west side of Colorado Boulevard to 72nd Avenue. It proceeds along 72nd Avenue to Colorado Route 2, following this right-of-way to 92nd Avenue. It follows 92nd Avenue along the north side of the Rocky Mountain Arsenal. The booster pump station is located just before Potomac Avenue along this route. The line follows the continuation of 92nd Avenue (Buckley Road) where it turns south, then continues on 88th Avenue (Irondale Road) eastward until reaching the edge of the Solids Drying and Distribution Site.

It is evident that the pipeline does not traverse any area which has not already been considerably disturbed. Since most of the route is along established road right-of-ways, no disruption of agricultural or any other land use will be caused by the pipeline construction. Some disruption of traffic and the usual increase in noise and dust which accompanies any construction effort will occur during the actual building of the pipeline.

FIGURE 1

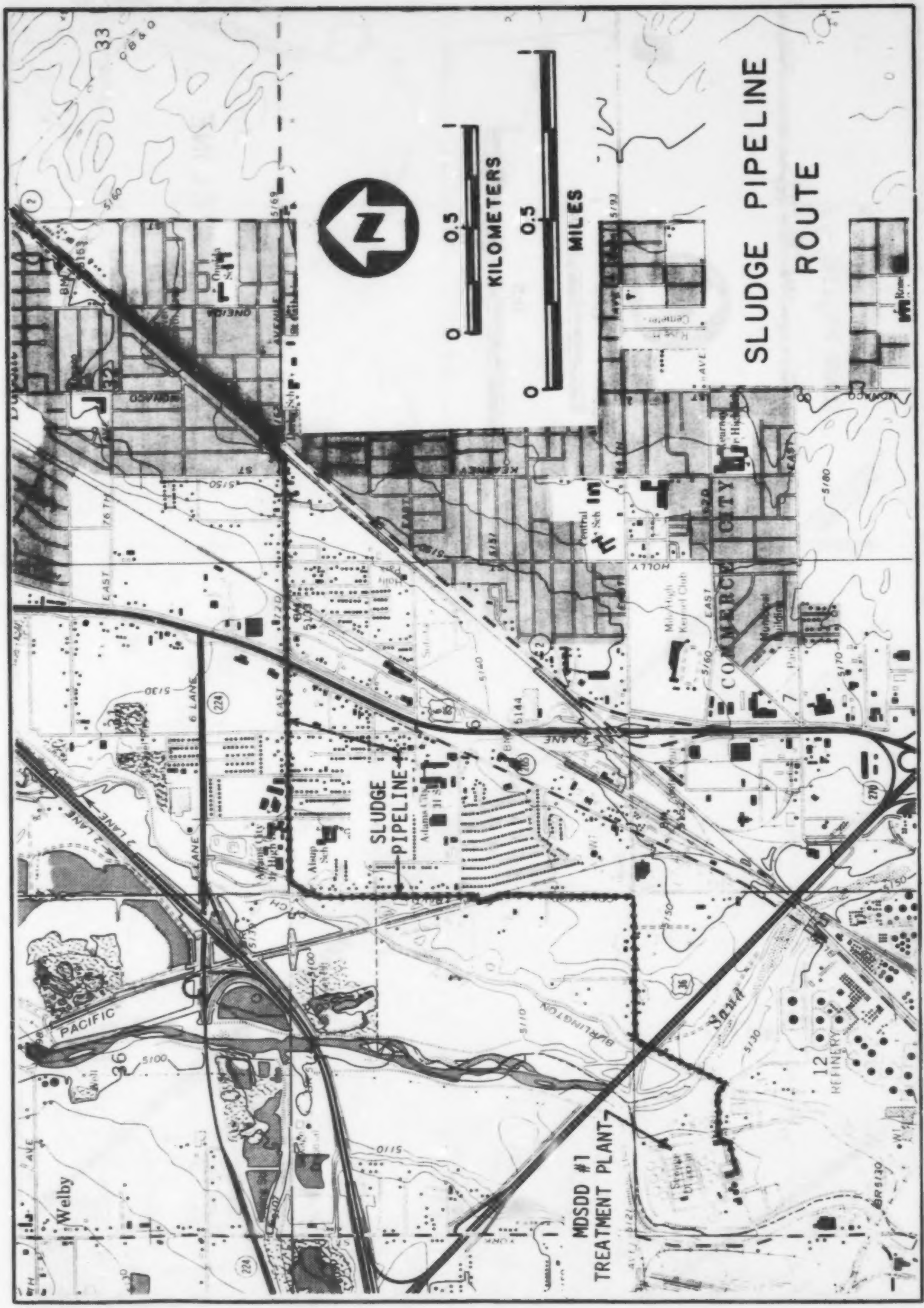
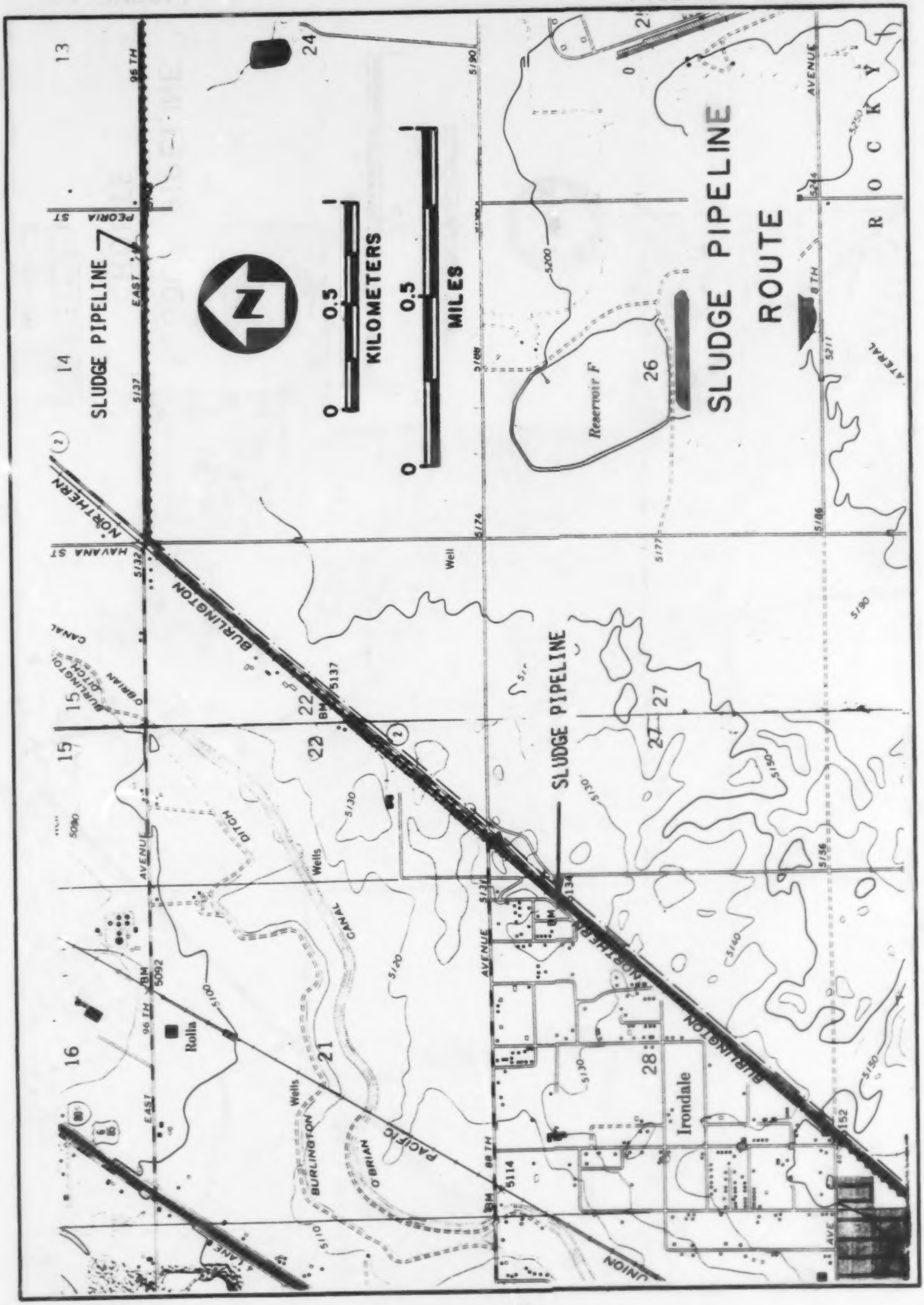

SLUDGE PIPELINE ROUTE
N
0
0.5
1
KILOMETERS
MILES
SLUDGE PIPELINE
MDSDD #1 TREATMENT PLANT
COMMERCE CITY
Welby
PACIFIC
BURLINGTON
Sand
REFINERY
6 LANE
2 LANE
EAST
HOLLY
KEARNEY
MONACO
ONEIDA
AVE
YORK
Adams City Jr High Sch
Alsup Sch
Central Sch
Mile High Kennel Club
224
270
36
2
5100
5110
5130
5150
5160
5170
5180

FIGURE 1 (cont'd)


SLUDGE PIPELINE ROUTE
SLUDGE PIPELINE
SLUDGE PIPELINE
KILOMETERS
0
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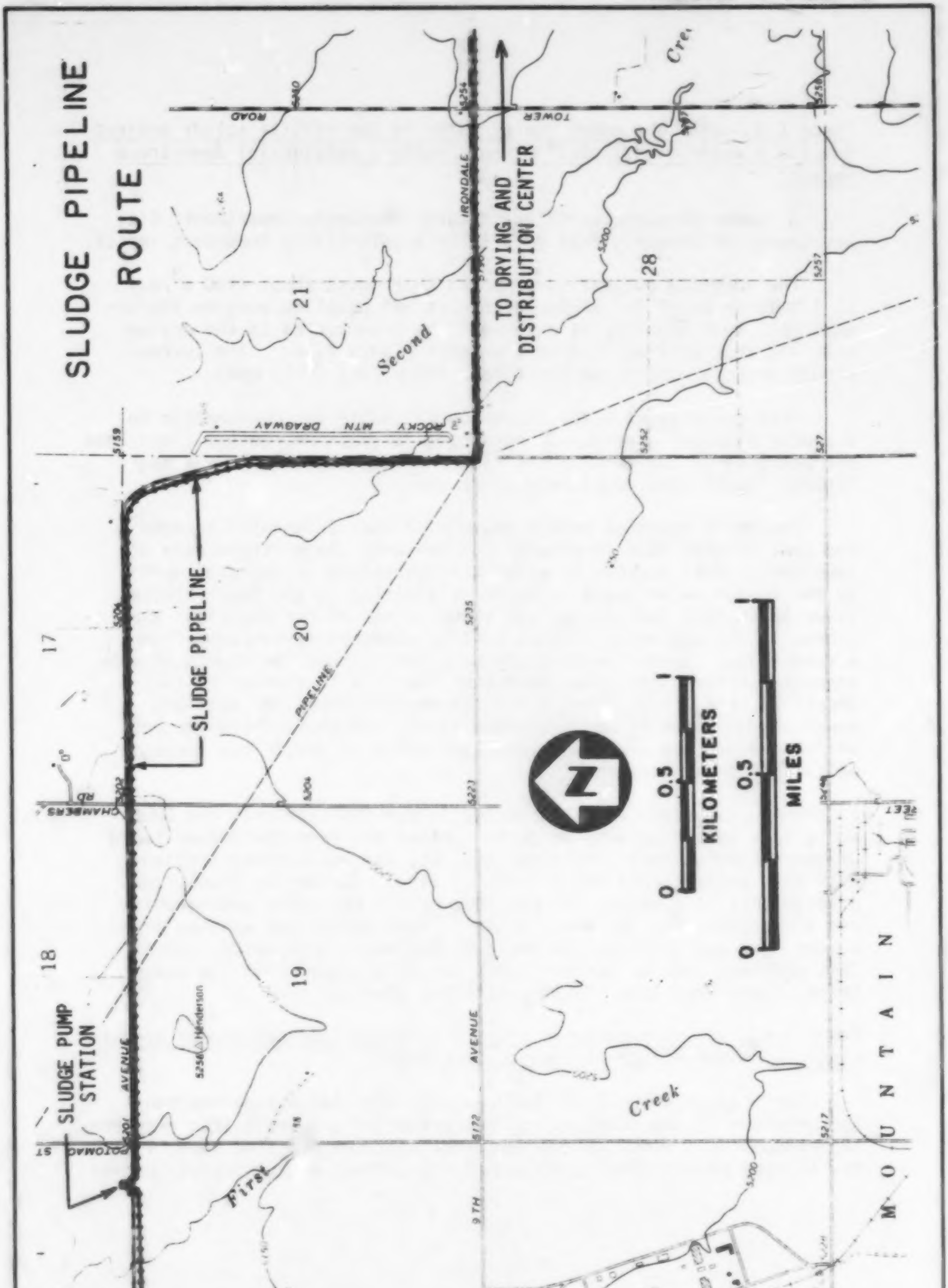
N
Reservoir F
Irondale
Rolla
BURLINGTON NORTHERN
UNION PACIFIC
BURLINGTON
O'BRIAN CANAL
BURLINGTON DITCH
O'BRIAN DITCH
CANAL
PEORIA ST
HAVANA ST
EAST 96TH AVENUE
EAST 88TH AVENUE
ROCKY
13
14
15
16
21
22
24
26
27
28
Wells
Well
5137
5132
5092
5114
5134
5152

FIGURE 1 (cont'd)


SLUDGE PIPELINE ROUTE
SLUDGE PUMP STATION
SLUDGE PIPELINE
TO DRYING AND DISTRIBUTION CENTER
POTOMAC ST
AVENUE
CHAMBERS RD
ROCKY MTN DRAGWAY
IRONDALE
TOWER ROAD
9TH AVENUE
PIPELINE
5256 Henderson
First
Creek
Second
Cre
MOUNTAIN
17
18
19
20
21
28
N
KILOMETERS
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1
MILES
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1

Issue I-3. Will the added use of water in the offsite solids project involve a water rights conflict and create a substantial downstream impact?

A number of agencies (State Natural Resources Department, City and County of Denver), felt this to be a potentially important impact.

The proposed project is expected to require about 4160 m^3/day (1.1 mgd) of water for sludge transport and pipeline purging (Reference 26). This quantity of water will be transported to the drying site and thus will be lost to the South Platte River. The current sludge disposal operation uses about 490 m^3/day (0.13 mgd).

This quantity of water is not unreasonable for consumption in a sludge disposal system. It represents a small percentage (less than one percent) of the total plant flow and its loss will have a negligible impact upon downstream users.

The Metro district treats wastewater that originates on both the east (Platte River drainage) and the west slope (transbasin diversions). Both sources of water are controlled or owned primarily by the Denver Water Board. Waters originating in the South Platte River basin that have historically been diverted for municipal use (through existing water rights) must be released downstream after a single use. Recent court cases have established the rights of subsequent use for waters that have been imported from other basins. Therefore, the Denver Water Board can be considered the outright owner of much of this western slope water. It would therefore be within the purview of the Denver Water Board to decide how these waters are to be managed.

EPA was particularly interested in the position that the DWB would take regarding this project. Letter #7, from the Denver Board of Water Commissioners, does not indicate any outstanding problems with this project from their point of view. The letter simply indicates that "the matter of use, however, is presently under review and discussion with the Metro staff." This letter was written over a year ago, and no change in position has been forthcoming. Given this apparent lack of conflict, EPA can only assume that the use of these waters are not a significant legal problem.

Issue I-4. Will the proposed project affect historical and/or archaeological resources and is a survey required?

The State Archaeologist has reviewed the sludge pipeline route and provided recommendations for protection of archaeological resources (Reference 10). Since the surface area that the pipeline route follows has already been seriously disturbed, no surface archaeological survey is required. The site B-2 has already been investigated and no significant artifacts were uncovered. Also, most of the pipeline follows the routes of various existing buried utility lines, so professional archaeological monitoring during excavation is not required. Professional monitoring will be required during excavation of the route through the plant site and up to Colorado Boulevard. The remainder of the trenching will require "informed, faithful" monitoring by Metro's excavation inspectors (Reference 10). Should archaeological resources be encountered, adverse impacts must cease until EPA and the State Archaeologist assess the cultural resource represented. At that time appropriate mitigative measures will be taken. See Grant Condition #2.

The State Archaeologist has presented the archaeological resource considerations for the sludge pipeline excavations, shown in Figure 2. This figure shows the archaeological situation and the appropriate measures required to ensure that destruction of historical resources does not occur. The implementation of these recommendations will adequately mitigate impacts to archaeological resources during pipeline construction.

Issue I-5. What is Metro's contingency plan for a pipeline break?

Metro has provided the following description of the pipeline design and operating procedure:

"In general, the transport system pipelines have been designed to be buried with a minimum of 5 feet of soil cover. This is approximately 1 foot deeper than the normal design practice in the Denver area for frost protection for utility pipelines. The reason for the deeper burial of the transport system pipelines was to locate the pipes so that they were relatively free from future disturbance during repairs on other utility pipelines or buried cables. The pipelines, of which there are two (a 10-inch and a 12-inch), have been designed with four cross-over valves to allow alternate use of sections of the pipelines if for some reason any one of the pipelines is unusable along any given stretch. Also, there are 18 blowoff valves along the pipelines for use in cleaning the pipelines of accumulated solid materials that may accumulate at the deeper points of the pipeline. There is an in-line valve at each blowoff to prevent flow in the pipeline downstream of the blowoff valves. Either the in-line valves of the blowoff valves or the crossover valves would be used in the case of a pipeline rupture. In-line valves located at the crossovers or the blowoffs would be closed to prevent back-drainage of the material in the pipeline out of the ruptured section of the pipe.

FIGURE 2

ARCHAEOLOGICAL RESOURCE CONSIDERATIONS FOR THE PIPELINE EXCAVATIONS

	PLANT SITE	SLUDGE LINE Plant Site to Colorado Boulevard	 Colorado Boulevard to Site B-2	DRYING AND DISTRIBUTION SITE
GENERAL SITUATION	Apparently previously and extensively disturbed	Generally disturbed along actual sludge line due to alignment with existing corridors		Largely undisturbed
GENERAL ARCHAEOLOGICAL RESOURCES Historical: Prehistorical:	 possible likely	 possible likely	 possible unlikely	 none[1] none[1]
STATE ARCHAEOLOGISTS' RECOMMENDATIONS FOR FOR ACTUAL EXCAVATION	Monitor with qualified archaeologist/historian		Monitor by EPA and Denver Metro excavation inspectors	

[1] Survey has revealed no resources.

Source: State of Colorado, State Archaeologist

Although the production of H_2S is definitely a product of anaerobic digestion, the amount of this gas produced can be minimized by proper operation of the anaerobic digesters at the Central Plant. Such operation would include maintenance of an adequate alkalinity level in the digesters to minimize the amount of free hydrogen ions and thus minimize the amount of H_2S produced. The transport system includes 21 combination air release valves (CARV). These valves have the ability to automatically release small accumulations of gas that may form in the pipeline at the high spots along the pipeline profile. The amount of this gas released at any one time will be small. Because relatively small quantities of gas will be released, no facilities for odor scrubbing or after-burning of any flammable gasses are provided. The amounts of these gasses would be too small to justify costly scrubbing or after-burning equipment at 21 locations."

In the event of a rupture in one pipeline, sludge would be pumped through the other pipeline until repairs were made. If both pipelines were ruptured in the same section, sludge transport would have to be temporarily halted until repairs were made. The main and booster pump stations are both equipped with four sludge pumps, of which two at each station are required at any time to pump sludge (Reference 46). This allows any two of the four pumps at each station to be inoperable without interrupting sludge flow.

This information will be developed into a contingency plan in the Operations and Maintenance Manual for this project. See Grant condition 3.a.

Issue I-6. How would Denver Northside Treatment Plant sludge be handled in the Metro offsite solids proposal?

This issue was by and large raised by the City and County of Denver in its comments on the draft EIS (see Letter #33). EPA is very much interested in the resolution of this issue, because it has important implications for Colorado wastewater treatment funding. To better understand the resolution of this issue, background information will be presented below concerning current operations at the Northside Plant in conjunction with the Metro plant, and a discussion of how the Northside operation would relate to the proposed Metro solids recycling plan.

The Denver Northside Plant (DNS), which is owned and operated by the City and County of Denver, is a 400,000 m^3/day (106 mgd) primary treatment plant located about 2.4 km (1.5 miles) upstream of the Metro plant in North Denver. The plant handles raw wastewater flows from the City of Denver as well as from some special districts surrounding

Denver. The Northside plant provides primary treatment only; the primary effluent is discharged through a 760,000 m^3/day (200 mgd) pipeline to the Metro Central plant for secondary treatment, as shown in Figure 3. Primary sludge withdrawn at the Northside plant is anaerobically digested onsite. Northside's digesters were recently upgraded under an EPA grant and have a total capacity of 36,000 m^3 [9.6 mil gal] (Reference 11). This volume is capable of processing sludge from a 470,000 to 510,000 m^3/day [125 to 135 mgd] primary wastewater plant (Reference 11). There is, therefore, considerable excess anaerobic digestion capacity at the Northside plant.

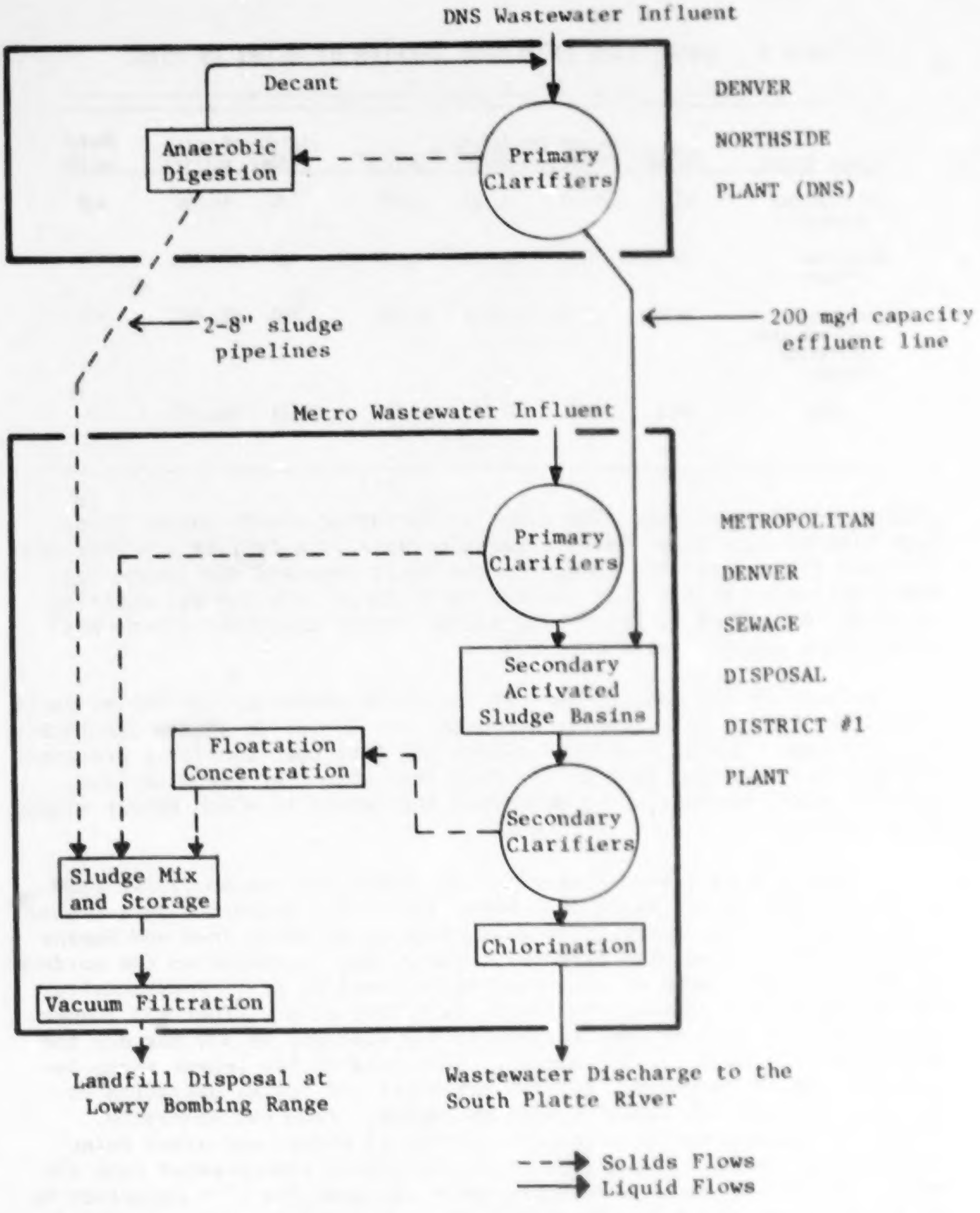
Before 1965, the Northside plant handled its processed anaerobic sludge in drying beds located at the plant site. The City stopped the use of these drying beds at the insistence of the Colorado Department of Health because of the groundwater pollution resulting from leaching of nitrates into the alluvium and eventually the South Platte River. The construction of the Metro Central plant in 1965 provided an acceptable alternative for disposal of Northside-generated sludge. Two eight-inch pipelines were constructed from the Northside plant to the Metro central plant for transport of Northside digested sludge to Metro for further treatment. The contract between the Metro District and the City calls for at least a 5 percent solids sludge to be pumped to Metro at Metro's expense. This means that the anaerobic sludge must first be settled and decanted, with the supernatant being returned to the primary treatment headworks.

The City and County of Denver Parks Department had historically used Denver anaerobically digested sludge as a soil conditioner in City-owned parks and golf courses. When the Metro Central plant was constructed, sludge incinerator-dryers were installed, presumably in part to provide a stabilized dried sludge for use by the Denver Parks Department. Up to 4100 dry metric tons/year [4500 dry tons/year] were to be used. Subsequent operational failures of the dryer/incinerators led to their abandonment in 1971. The present system of disposal by truck hauling vacuum filtered sludge to a portion of the Lowry Bombing Range (owned by the City of Denver) was implemented at this time.

The Metro Central plant currently handles all sludges generated at both the Metro plant and from Northside by vacuum filtration and truck hauling to the Lowry landspreading site. The relative amounts of sludge from the different sources that were treated by Metro in 1976 are given in Table 5.

Northside sludge constitutes only about 13 percent of the total Metro sludge load by weight and about 11 percent by volume. More importantly, digested primary sludge dewaters quite well. Metro's cost of sludge operation is very sensitive to two factors: 1) the cost of chemicals to aid in sludge dewatering and 2) the degree to which the

FIGURE 3


DNS Wastewater Influent
Decant
Anaerobic Digestion
Primary Clarifiers
DENVER
NORTHSIDE
PLANT (DNS)
2-8" sludge pipelines
200 mgd capacity effluent line
Metro Wastewater Influent
Primary Clarifiers
METROPOLITAN
DENVER
SEWAGE
DISPOSAL
DISTRICT #1
PLANT
Secondary Activated Sludge Basins
Floatation Concentration
Secondary Clarifiers
Sludge Mix and Storage
Chlorination
Vacuum Filtration
Landfill Disposal at Lowry Bombing Range
Wastewater Discharge to the South Platte River
Solids Flows
Liquid Flows

SCHEMATIC DIAGRAM OF EXISTING DENVER NORTHSIDE AND METRO DENVER TREATMENT PLANT PRINCIPAL UNITS AND FLOWS

Table 5. QUANTITIES OF SLUDGE TREATED BY METRO IN 1976

	Weight Dry Solids				Volume of Water		%Total Solids
Sludge Origin	mt/day	tons/day	mt/yr	tons/yr	m^3/day	gal/day	
DNS digested primary	12.1	13.3	4,427	4,870	175	46,580	5.0
Metro raw primary	33.1	36.4	12,950	14,250	467	123,290	7.1
Metro raw concentrated activated sludge	39.0	42.9	14,410	15,850	881	232,880	4.4
Total	84.2	92.6	31,790	34,970	1,524	402,750	-

sludge can be dewatered. The digested Northside sludge has at times been blended with other Metro sludges because it acts like a sludge conditioner and reduces the amount of chemicals required for dewatering. Metro estimated that a cost savings of $2.00 per dry ton was achieved on sludge processed at Metro by blending Denver anaerobic sludge with other Metro sludges (Reference 42).

Because of the continuing need for dried sludge by the Denver Parks Department, Metro has recently processed the Northside sludge separately for park use. Denver anaerobic sludge has also been similarly processed for use in reclaiming land at the AMAX Urad mine near Berthoud Pass. Metro's recent communication described the manner in which Denver sludge is processed:

"Polymer conditioned anaerobically stabilized vacuum filter cake is loaded into Denver Parks Department trucks for transport to a drying site located on the Denver City Jail property at Smith Road and Havana Street (east of Stapleton Airport). The sludge is spread on the surface of the soil to a depth of 12 inches and allowed to dry. Occasionally during the drying process the sludge is turned with a front-end loader. This operation results in a savings to the District of $30 per dry ton of sludge processed in this manner. Officials of the Denver Parks Department report their cost for the transport and drying operation to be about $16 per dry ton of sludge processed. From the stockpile, sludge is transported to parks in the City of Denver and areas being developed as parks. The sludge is spread and/or incorporated into the soil. The Denver Parks officials report the cost for this operation to be $2 to $4 per dry ton. There have been no special controls applied to the application of sludge to the land being developed as parks. Location of several parks which have been developed or have otherwise utilized sludge as fertilizer are as follows:

1) *Ruby Hill Park*
West Jewel and South Platte River

2) *Crestmoor Park*
1st Avenue and Monaco

3) *Cook Park*
Monaco and Cherry Creek

4) *Washington Park*

5) *Hampden Heights Parks*
Cornell and Dayton".

Since the inception of the Metro offsite solids program, it has always been assumed that Northside sludges would be included in the reuse system. Recently the City has proposed that a separate sludge disposal system involving rehabilitation of the sludge drying beds at Northside be studied in a separate facilities plan (see Letter #33, from the City and County of Denver). This issue is discussed under Issue IV-4.

EPA became concerned in the course of the review of the draft EIS that design for Northside sludge treatment by Metro consider three important factors involved with the proposed offsite solids system:

1.) In a letter to the Metro District, EPA recognized the fact that the Northside plant must maintain under contract a 5 percent dry solids sludge concentration for sludge pumped to the Metro plant. This requires a substantial decant to be returned to the primary clarifier system at Northside and eventually to the Metro Plant.

With the Metro solids management plan, no decant return to the Metro central plant is envisioned, Both decant and sludge solids would be pumped to the drying basins. This would have the triple advantage of retaining additional nutrients in the sludge stream, removing nutrients from the wastewater, thus reducing the load on the treatment plant, and eliminating the necessity to dewater the anaerobically digested sludge at the plant.

EPA questioned whether the same arrangement could be used for Denver Northside sludge in the long-range Metro solids management plan; that is, to include the Northside decant from the anaerobic digesters in the pipeline. It appeared that such an arrangement could have a substantial cost benefit as well, by removing a portion of the biochemical oxygen demand (BOD) and suspended solids load on the Metro plant that ultimately is converted into the difficult-to-dewater waste activated sludge. EPA also felt that the City could benefit as well in this situation through reduced charges for BOD and suspended solids entering the Metro plant and with reduced sludge handling costs.

2.) Another point that concerned EPA was the primary/secondary sludge imbalance between the Metro and Northside plants. Denver Northside processes only primary sludge, while the great bulk of Metro sludge is secondary waste activated (WAS). It could well be the case that optimum operation of the Metro digesters may require blending with primary sludge. It appeared that separating the operations of the two plants might foreclose this option. EPA also wanted to know if removal of Northside digested sludge would have any effect on Metro sludge drying times.

3.) The third point that concerned EPA was the future availability of dried sludge to Denver Parks Department in view of the great distance from the proposed drying site to the downtown Denver area. EPA recognized that there were certain benefits to having dried sludge available close to markets in the Denver metropolitan area, such as the Denver parks. It is also the case that other municipalities have expressed an interest in using dried sludge on park lands. Perhaps drying some portion of the sludge on the Northside drying beds could provide a less expensive means to provide sludge to willing users in the core metropolitan Denver area.

Metro responded to each of these points in turn. The following constitutes Metro's view of how the Northside-Metro sludges would be handled with the offsite solids system:

"1. *It is anticipated that when the proposed system is operational, Denver will send their anaerobic digester contents in entirety to the Metro District for transport to the drying/distribution center. It should be pointed out that Metro, in cooperation with Denver, will attempt to manage both facilities to provide the greatest cost benefit possible. It will, however, be necessary for Metro and Denver to continue to return their decant from the anaerobic digestion process to the primary treatment facilities until the new drying basin project is completed. At that time, it is anticipated that all supernatant or decant will go to the drying basin for drying; the primary reasons for this are outlined by you in your comment regarding triple advantages. . .*

2. *The operation of the Metro District facility and the Denver Northside facility area are, and have been, under separate management*

> *and control. However, Metro and Denver Northside staffs have worked diligently through an Operations Coordinating Committee to bring about optimization of both facilities. It is envisioned that this endeavor will continue throughout the years. It is impractical for one facility to be operated in a manner which would not complement the operation of the other. The imbalance of sludge (waste activated to primary) will continue to be a major problem for both facilities. With regard to the question of drying times, it is impossible to predict drying time effects at this time because the sludge in question has not yet been produced by the Metro facilities. . .*
>
> *3. In response to the comment regarding flexibility, we feel this point is the single most important consideration in the operation of the two facilities. For example, if Denver Northside sludge could be dried at the Denver Northside facilities or could be sent to Metro or any conceivable configuration between these two extremes, the greatest cost benefit for both facilities would be realized."*

On the latter point, Metro has very recently indicated that they are studying the possibility of drying and storing a limited amount of polymer dried anaerobic vacuum filtered sludge at the Metro plant site. The Parks Department would then be able to haul the dried sludge directly to parks from the Metro plant rather than haul the sludge to the Denver Jail site near Stapleton for further drying. Cost savings to the Denver Parks Department could then be achieved.

Therefore, the current Metro plan for Northside sludge management in the offsite solids project calls for pumping most or all of the Northside sludge and decant to the offsite solids drying area, except for occasional vacuum drying of limited amounts of digested sludge at the Metro site. If the sludge is dried to the 20 percent cake solids now achievable with Denver vacuum filtered digested sludge, there should be no leachate problem at the Metro plant site. A certain amount of ground preparation to contain occasional rainfall runoff should adequately protect the South Platte River. Because this option is still very preliminary, the definitive information on tonnage and design is unavailable. Such an operational change would require an NPDES permit change and would be extensively reviewed. With the full decant from Northside being sent to the offsite solids site, the quantities of total sludge volumes expected in the 1985 design year are given in Table 6. The expected increase in sludge volume would be on the order of 8.5 percent, which is only a minor increase to the system. EPA discusses the capacity of this system under Issues II-12 and II-13. There appears to be sufficient capacity to handle this flow. There will also be a minor increase in operational costs.

EPA believes that close cooperation between the Denver Northside and Metro Districts is essential to optimum performance of this proposed offsite solids system. The system does have promise to reduce costs to both districts if carefully managed. Metro and Denver should begin negotiating necessary agreements, including amending the contract calling for a 5 percent solids from DNS if necessary.

Table 6. PROJECTED 1985 SLUDGE QUANTITIES TO BE DRIED AT DRYING AND DISTRIBUTION CENTER

	Weight Dry Solids		Volume of Water		Percent
Sludge Origin	mt/day	tons/day	m^3/day	gal/day	Total Solids
DNS digested primary w/o decant	18.2	20	360	95,000	5.0
DNS digested primary w/decant	18.2	20	640	170,000	2.8
Metro primary digested and concentrated WAS	81	89	2930	775,000	2.8
Total w/o decant	99	109	3300	871,000	3.1
Total w/ decant	99	109	3580	945,000	2.8

SECTION II

DRYING AND DISTRIBUTION SITE ISSUES

ISSUE II-1. Please provide a better description of existing conditions at Site B-2 and a better definition of on-site environmental impacts.

The general environmental setting of Site B-2 is described in Section III and Appendix E of Volume I of the EIS. The site is more or less visually indistinguishable from the surrounding area, most of which is used for dryland wheat farming. This section discusses some of the existing conditions at Site B-2 which will be directly affected by the sludge drying and distribution center. Particular emphasis is given to the geology and geohydrology and the potential for groundwater contamination.

Loss of Productivity

As noted above, Site B-2 is currently used for dryland winter wheat farming. This land will of course be lost to wheat production when the drying and distribution center is built. This is a loss of about 810 ha [2000 acres] of productivity.

The B-2 site is now under the ownership of several individuals; a 320-acre section is also owned by the State of Colorado. As it now stands, no one owner will lose more than 320 acres, except perhaps for Mundell, who has part ownership of one-half section and ownership of another within Site B-2. Because of the dispersed nature of the pieces of land cultivated by dryland farmers of the area and the relatively large size of these farms, it is not believed that purchase of these lands in B-2 will result in any individual farming operation being put out of business. This statement is made primarily because of a lack of evidence to the contrary; none of the current owners who have commented on this EIS (Meyer, Bennett, Mundell) have indicated such a situation. A map of the current owners can be found in the attachments submitted by John Kalcevic (see Letter #41).

In 1975, the site was estimated to have a productivity similar to that of Adams County in general. This was 27 hl*/ha [30 bu/acre]. In Adams County, some 53,000 ha [131,000 acres] of land is dryland farmed. In addition, about 1,600 ha [4,000 acres] of land is used for irrigated wheat farming and some 21,700 ha [53,600 acres] for other irrigated and non-irrigated crops. The loss of 810 ha [2,000 acres] therefore represents a loss of 1.5 percent of the total wheat acreage, and a loss of 1.0 percent of the total farmland acreage in Adams County. Assuming an average price of \$9.62/hl [\$3.50/bu] for wheat, the financial sales loss to the county will be about \$105,000/yr (Reference 12). This represents less than one percent of the total value of all crops produced in Adams County in 1972 and 1973. Some of this impact may be mitigated by having agricultural production on the research and demonstration portion of the site (roughly 530 ha [1300 acres] out of 810 ha [2000 acres] could be used).

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*hl = hectolitre (100 litres)

Surface Water Resources

As noted in Volume I of the EIS, the site has no perennial streams or other bodies of surface water and is located on slightly higher ground than the surrounding terrain. When rainfall occurs, the site does not receive runoff from outside its borders, except on two ephemeral streams bordering the site, Lost Creek on the eastern edge and Horse Creek on the western edge. Lost Creek flows to the north-northeast, Horse Creek to the north-northwest.

Geology

The site lies within the Denver Basin on the western edge of the Lost Creek Drainage Basin. The general geology of the Denver Basin is described in Section III and Appendix E of Volume I.

In order to assess more precisely the subsurface geology at the site, a geotechnical investigation was carried out in 1976 (Reference 13). This investigation was conducted by examination of a number of test pits and holes at the B-2 site. The investigation found that eolian (windblown) deposits blanket most of the site, with alluvial (stream-deposited) soil being found at the extreme southeast corner of the site. Soil types beneath the site consist of: silty and sandy clay, silty to clean, fine sand, clayey and silty sands, and silty to clean, well graded sands and gravel. Bedrock consists mostly of interbedded claystones and sandstones. Transition from soil to parent bedrock is often gradual. Clayey soils probably make up about two-thirds of all soil types present, with most of the rest being silty to clean, fine sands. Depth to bedrock varies from about 0.6 m [2 feet] to 12 m [38 feet]. No free groundwater was encountered in any of the test pits or holes.

The bedrock beneath the site consists of conglomerates, sandstones, siltstones, and shales of the Arapahoe, Denver and Dawson formations. These formations are all quite similar in character and are often indistinguishable from each other. The bedrock is weathered and partially decomposed and is easily broken. It tends to be close to the surface near the topographic highs at the site and somewhat deep near the topographic lows. In other words, the bedrock surface generally is reflected by the ground surface so the flow of any perched groundwater beneath the site will most likely be in the same direction as surface water (Reference 14). The site is located on a topographic ridge, with drainage to the north-northeast, along Lost Creek, on the eastern side, and to the north-northwest, along Horse Creek, on the western side. Flow of a perched aquifer formed from bed leachate would likely also follow these stream channels.

The Arapahoe, Denver and Dawson formations have small to moderate groundwater yields and are tapped primarily for livestock and domestic wells in the region of Site B-2. The sandstone members of these formations are the water bearing strata. The clay, siltstone and shale strata act as aquitards, or barriers to groundwater flow. Sand, gravel, and conglomerates with minor amounts of clay in the lower part of the Arapahoe formation have somewhat higher though still moderate yields of water.

Below the Arapahoe, Denver and Dawson formations are the Fox Hills and Laramie sandstones. These occur approximately 300 to 370 m [1,000 to 1,200 feet] below the ground surface in the vicinity of Site B-2 (Reference 15). These sandstones yield small to moderate quantities of water to domestic, stock, public supply and industrial wells throughout the area. The Fox Hills sandstone is the most prolific of the deep bedrock formations (Reference 15).

Groundwater Flow Beneath Site B-2

On the basis of the U. S. Geological Survey (U.S.G.S.) survey of the Lowry Bombing Range area and of the geotechnical investigation of Site B-2 (References 16 and 13), Stanley Robson of the U.S.G.S. has made estimates of the probable groundwater flow beneath the site (Reference 14). At present no perched aquifer in the unconsolidated sediments of the site exists. If the rate of leaching from the drying beds exceeds the vertical water flow into the bedrock, then a perched aquifer will form in the overlying unconsolidated sediments. The flow in this aquifer will for the most part follow the slope of the bedrock surface, which tends to be congruent with the land surface. The bed leachate would then flow along the route of Horse Creek to the north-northwest and Lost Creek to the north-northeast. Robson estimates the rate of lateral flow in this aquifer would be 0.17 m/yr [0.55 feet/yr], assuming the permeability of the sediment to be 1.8×10^{-2} m/day [6×10^{-2} ft/day], a porosity of 0.25, and a hydraulic gradient of 6.2×10^{-3}.

If the rate of leachate flow through the beds is not greater than the rate of vertical movement in the bedrock, then no perched aquifer will form. In this case, leachate from the beds will move downward into the bedrock below the site, and will eventually reach the bedrock aquifers. This leachate would be mixed with the water already in the bedrock aquifers. Robson has calculated the approximate flow of water in the upper bedrock aquifers. Assuming the same lateral permeability as used in the Lowry Bombing Range study of 0.86 m/day [2.8 ft/day] and considering only the upper 91m [300 feet] of the bedrock aquifer, then 3.1×10^5 m^3/yr [250 acre-ft/yr] of groundwater will cross the southern boundary of the drying site. Presumably this would be the approximate yearly volume of water available for dilution of the leachate from the beds which reaches the upper 91m [300 feet] of the bedrock aquifer.

A real-world situation could also occur where both a perched aquifer forms and some bedrock aquifer recharge takes place. This could happen if the unconsolidated sediments are generally more permeable than the underlying bedrock. However, if the bedrock is occasionally discontinuous or if there is a permeable outcrop of a porous bedrock material such as sandstone, recharge to deeper aquifer could occur. The exact flow under this situation cannot be precisely determined until actual unconsolidated flow of leachate takes place.

The quantity of leachate which percolates from the beds will depend on the permeability of the bed lining, the depth to which the beds are loaded, and the area of beds actually leaching water at any given time. This factor is discussed in the following section.

ISSUE II-2. Will groundwater deterioration occur, particularly to the Lost Creek aquifer, and what mitigating measures such as lining are necessary?

From the data obtained during the geotechnical investigation of the soils at the site, it was determined that neither the upper unconsolidated deposits nor the upper bedrock strata were saturated (Reference 13). In most of the test holes and pits, the bedrock-unconsolidated deposit interface consists of low-permeability claystone or more permeable siltstone. Leachate or groundwater could move through the siltstone stratum if saturated conditions occurred.

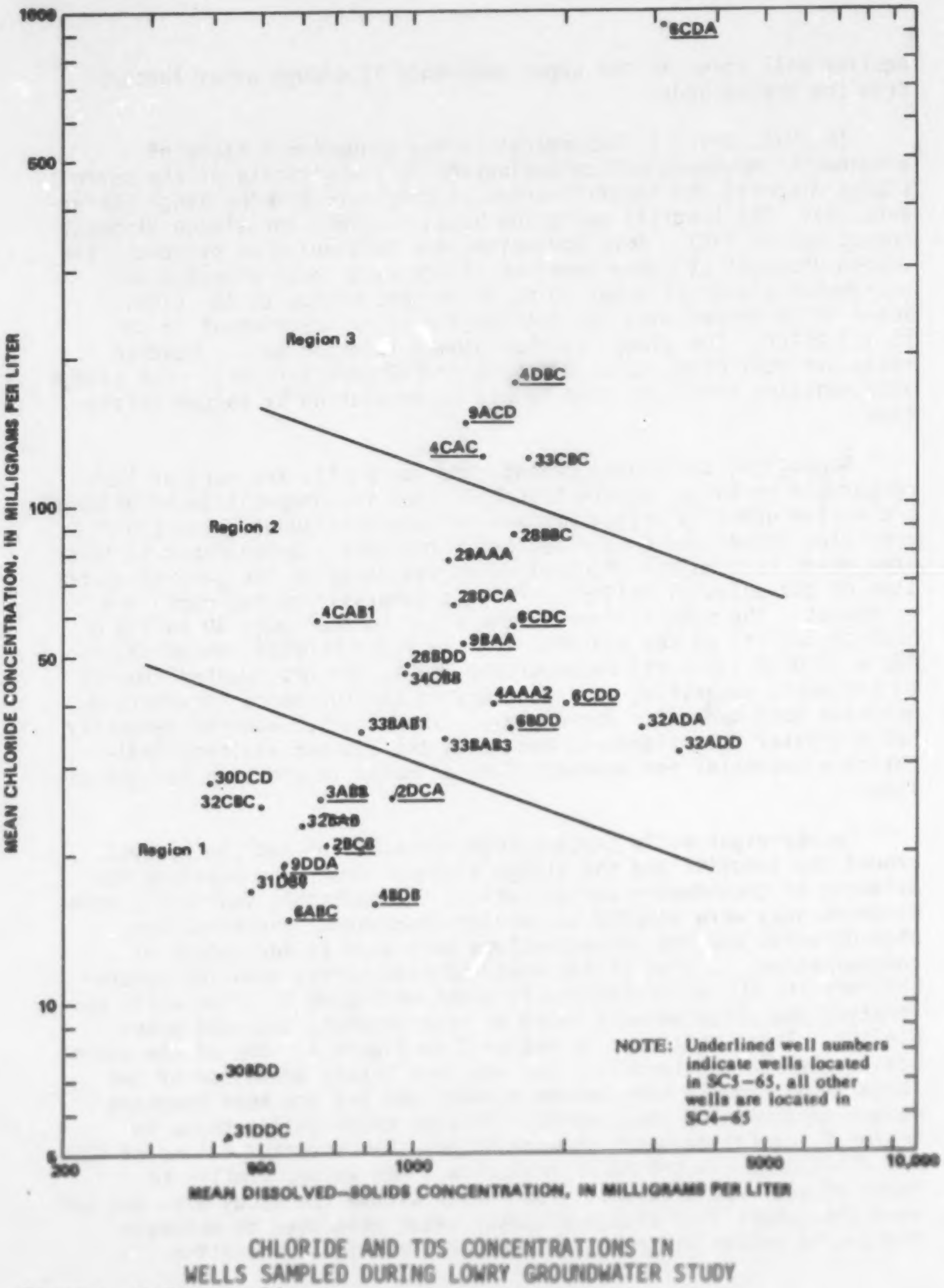
The unconsolidated sediments overlying the bedrock have permeabilities estimated to range from 10^{-2} to 10^{-3} cm/sec [28 to 2.8 ft/day] for clean sands to around 10^{-7} cm/sec [2.8×10^{-4} ft/day] for silty sands and clays (Reference 13). Permeabilities in the higher range would allow significant leachate flow within the unconsolidated sediments. If the vertical flow of water into the bedrock formation is very slow, as seems likely, then a perched groundwater aquifer will form in the upper sediments if enough water leaches from the drying beds.

In 1976, the U.S. Geological Survey conducted a study of groundwater movement and contamination in the vicinity of the current sludge disposal and landfill areas at the Lowry Bombing Range (Reference 16). The landfill operation began in 1966, and sludge disposal operations in 1969. Both operations are continuing at present. The sludge disposal at Lowry consists of trucking both digested and undigested sludge of about 10 to 16 percent solids to the site, where it is dumped onto the soil in a uniform layer about 15 cm [6 in] thick. The sludge is then plowed into the soil. Loading rates are very high, about 67 mt/ha/yr [30 tons/acre/yr]. The sludge also contains chemicals used to aid in dewatering by vacuum filtration.

Geological conditions beneath the Lowry Site are more or less comparable to those beneath Site B-2; that is, unconsolidated alluvial and eolian deposits with a maximum thickness of about 7.6 m [25 ft] overlying Denver and Dawson bedrock formations. Groundwater in this area moves through the unconsolidated sediments in the general direction of the alluvial valleys. This is generally to the north and northwest. The same is true of the water in the upper 30 to 110 m [100 to 350 ft] of the bedrock. In the lower bedrock, about 170 to 480 m [570 to 1,570 ft] below ground level, the groundwater flow is to the west, suggesting that aquifers in the two depth intervals do not have good hydraulic connections. The alluvial aquifer generally has a greater potentiometric head than the bedrock aquifers indicating a potential for downward flow of water in addition to lateral flow.

Twenty-eight wells tapping both the alluvium and the bedrock around the landfill and the sludge disposal area were examined for evidence of groundwater contamination. In addition, four wells some distance away were sampled to provide background concentrations. High chloride and TDS concentrations were used as indicators of contamination. A plot of the mean chloride versus mean TDS concentrations in all wells sampled is shown on Figure 4. Five wells perforating the alluvium were found to have markedly degraded water quality. These wells are in Region 3 on Figure 4. One of the wells was located in the landfill, two are immediately downslope of two large areas used to bury sewage sludge, and two are near stagnant manure-contaminated stock ponds. Fifteen other wells, those in Region 2, contained water showing higher than expected values of TDS and chlorides, and ten wells in Region 1 had values similar to those of background values. Four wells within the study area but not near the landfill or sludge-disposal areas were used to estimate background values since no analyses were available predating

FIGURE 4



CHLORIDE AND TDS CONCENTRATIONS IN
WELLS SAMPLED DURING LOWRY GROUNDWATER STUDY

Source: Reference 16

commencement of landfill operations in 1966. These were wells 31DDC, 30BDD, 9DDA, and 3ABB, in Region 1 on Figure 4.

Water from twelve wells perforating the upper bedrock were also examined for evidence of degradation. Although chloride concentrations were higher than background values in two wells, no discernable degradation was found in upper bedrock groundwater. Analyses on water from three wells perforating the lower bedrock also show no effects.

The conclusion from this study is that the primary negative effect of the sludge disposal operation at Lowry has been on the alluvial aquifer, with no discernible effects as yet on deeper water-bearing strata. The alluvial degradation is not yet serious; however, the potential definitely exists for groundwater deterioration from sludge leachate, and for this reason every effort should be made to minimize the quantity of leachate allowed to percolate into the ground.

Groundwater Quality Requirements at Site B-2

The EPA policy for the proposed project shall be that all chemical, biological and pesticide criteria specified in EPA's Manual for Evaluating Drinking Water Supplies will be met for permanent groundwaters potentially affected by percolate from the site (Reference 17). Where a drinking water parameter in the groundwater already exceeds the criteria, no further degradation will be allowed. There will also be no significant deterioration of other parameters (such as TDS) which would impair any other existing uses of the groundwater in and around the site.

The U.S.G.S. has recently made a survey of the wells in the vicinity of the site. The well locations, depths, water levels and uses are given in Table 7. The location of each well is also shown on Figure 5. These wells would be the first to show any deterioration of water quality in the event that bed leachate reaches the bedrock aquifer.

Lining of Drying Basins

In order to reduce as much as possible the quantity of leachate entering the ground from the drying beds, EPA will require the equivalent of a clay liner beneath all beds. This liner will be at least 0.30 m [1 ft] thick, and have a permeability less than or equal to 1.0×10^{-7} cm/sec [2.83×10^{-4} ft/day]. Liners with these characteristics could be at least partially constructed by compacting clays available onsite. Liners with this permability will keep the infiltration of leachate from the beds into the groundwater below the site

Table 7. WELLS IN THE VICINITY OF PROPOSED DRYING AND DISTRIBUTION CENTER

Reference Letter[1]	Location[2]	Depth m	Depth ft	Water Level Below Land Surface m	Water Level Below Land Surface ft	Date of Water Level Measurement	Use
A	2S-64W-2ADD	79.3	260	38.72	126.99	6/77	Domestic
B	-4BBC	-	-	37.10	121.7	6/77	Domestic
C	-5ABD	54.9	180	33.13	108.63	5/77	Domestic
D	-5CAC	-	-	-	-		Abandoned
E	-6BBB	122	400	53.11	174.2	5/77	Domestic
F	-6CAB	134	440	49.2	161.43	6/77	Abandoned
G	-6DDC	101	330	27.4	90	7/74	Domestic
H	-7DAA	83.5	274	-	-		Domestic
I	-8CBC	82.3	270	-	-		Stock
J	-10CDD	93.6	307	54.9[3]	180[3]		Domestic
K	-11DDD	39.6	130	29.37	96.36	5/77	Abandoned
L	-14BCD	30.5	100	22.80	74.79	5/77	Abandoned
M	-14CAB	30.5	100	-	-		Domestic
N	-17DAA	44.2	145	27.88	91.45	5/77	Abandoned
O	-18CCB	76.2	250	7.83	25.67	6/77	Domestic
P	-19BCC	84.5	277	7.6	25	1965	Domestic
Q	-19CBC	11.1	36.5	7.15	23.44	6/77	Irrigation
R	-20DDC	37.5	123	Dry			Abandoned
S	-22CBC	70.1	230	33.63	110.3	5/77	Abandoned
T	-23DBA	24	80	Dry at 16.5 m [54 ft]			Abandoned
U	-28AAB	-	-	Dry at 15.6 m [51 ft]			Abandoned
V	-31DAA	20	66	5.72	18.76	-	Domestic
W	-34BCA	-	-	27.41	89.90	5/77	Abandoned
X	-35CCC	30	97	25.63	84.09	5/77	Abandoned

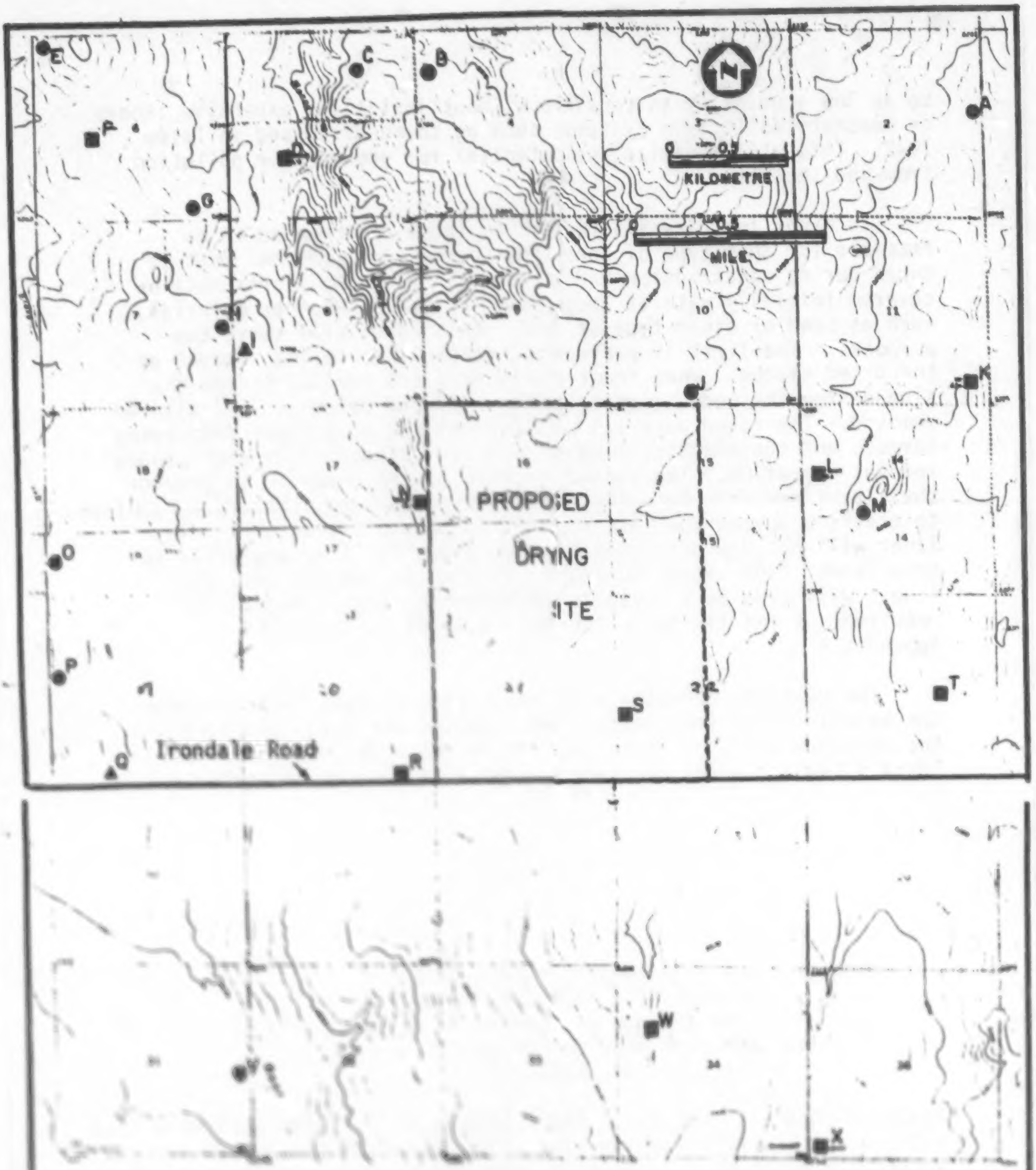
Source: Reference 22 except where noted

[1] Refers to Map Location on Figure 2

[2] Location based on U.S.G.S. system for locating wells (see Reference 16)

[3] Source: Reference 23

FIGURE 5


E
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X
0
0.5
KILOMETRE
MILE
PROPOSED
DRYING
SITE
Irondale Road

LEGEND

● DOMESTIC WELL

▲ IRRIGATION OR STOCK WELL

■ ABANDONED WELL

WELLS IN THE VICINITY

OF SITE B-2

to as low a quantity as possible without installing expensive liners or leachate collection systems, such as those discussed in Issue IV-2. This will minimize the potential for groundwater pollution from bed leachate.

In order for clay liners such as those recommended to be feasible for this type of operation, certain precautions must be taken during construction and operation. The clay liners must be covered initially with at least 30 cm [1 ft] of another material, such as sand or other type of soil. This cover will serve two purposes. The first is protection of the liner during removal of the dried sludge. When front-end loaders are used to scrape the sludge from the beds, a certain amount of bed material will also be removed. The cover material will prevent the clay liner from being harmed, and the quantity removed must be replaced after each sludge removal operation. The second function of the cover is to prevent the clay liner from becoming excessively dried and, therefore, subject to cracking during the latter stages of sludge drying. The clay liner will not dry out completely and crack if it is protected in this manner from direct sunlight. With these precautions, clay liners will provide a suitable liner for the drying beds. The requirements for lining are set out in Grant Condition #5 in Appendix A.

The quantity of water which will leach through these linings can be calculated from Darcy's Law, knowing the total bed area and the pressure head, or depth of water in the beds (Reference 18). Darcy's Law for water leaching through a medium can be stated as:

$$Q = KA\left(\frac{H}{L}\right)$$

where Q = volume of water leached, m^3/sec
K = permeability of medium, m/sec
A = area through which water is leaching, m^2
H = pressure head through medium, m
L = thickness of medium, m

Assuming that half the total 243 ha [600 acres] of beds will have free water available for leaching at any time, and that these beds contain water at a depth of 0.61 m [2 ft], then the quantity of water leached will be:

$$(1.0\text{x}10^{-7}\frac{\text{cm}}{\text{sec}})\text{x}(\frac{243}{2}\text{x}10^{4}\ \text{m}^2)\text{x}(\frac{0.61\text{m}}{0.30\text{m}})\text{x}(\frac{1}{100}\ \frac{\text{m}}{\text{cm}})\text{x}(24\text{x}3600\text{x}365)=76{,}600\ \text{m}^3/\text{yr}$$

$$[(2.83\mathrm{x}10^{-4}\ \mathrm{ft/day})\mathrm{x}(\frac{600\ \mathrm{ac}}{2}\mathrm{x}43{,}560)\mathrm{x}\frac{2\ \mathrm{ft}}{1\ \mathrm{ft}}\mathrm{x}\ 365 = 2.70\mathrm{x}10^{6}\ \mathrm{ft}^3/\mathrm{yr}]$$

This is the maximum quantity of water which should leach from the beds because the soils may become even less permeable after sludge application. Several investigations (References 19, 20, 21) have found that soils beneath holding ponds tend to become less permeable after animal wastes have been applied to them. The process generally occurs over periods of weeks. The same phenomenon would be expected to occur when sludge is applied to clay soils. Tests conducted by Metro at a site in Greeley, Colorado, using Denver sludge, found that the permeability of sandy soils decreased to almost zero within a year after sludge application. The soil permeability in all of these investigations returned to its original value after being dried, so the mechanism by which clogging occurs is a reversible one.

Leachate Flow in Unconsolidated Sediments

If the leachate from the beds forms a perched aquifer below the site, the water will likely flow laterally through the unconsolidated sediments along the bedrock surface. Occasional fracturing or outcropping of porous bedrock formations could still result in some percolation to deeper aquifers. The site lies on a slight ridge which runs roughly from its southwest corner to the midpoint of the north border. Approximately one-third of the site lies to the west of the ridge and two-thirds to the east. This means that about one-third of the perched aquifer will flow to the north-northwest, along Horse Creek, and two-thirds to the north-northeast, along Lost Creek.

North-Northeast Flow Rate - -

Robson of the U.S.G.S. has estimated the lateral flow rate in the unconsolidated aquifer would be 0.17 m/yr [0.55 ft/yr]. He assumes a sediment permeability of $2.1\mathrm{x}10^{-5}$ cm/sec [$6\mathrm{x}10^{-2}$ ft/day], a porosity of 0.25 and a hydraulic gradient (slope) of $6.2\mathrm{x}10^{-3}$.

Data describing the hydrologic character of the alluvium in several areas approximately 25 km [15 mi] southeast of the site found that the hydraulic conductivity of the alluvium ranged from $2\mathrm{x}10^{-3}$ to 40 m/day [$8\mathrm{x}10^{-3}$ to 130 ft/day]. The mean was 10 m/day [32 ft/day]. The mean value is close to the highest permeability estimated at the site for clean sands in the unconsolidated sediments (Reference 13). Using this hydraulic conductivity as a closer estimate of the permeability of the sediments underlying the site than that used by Robson, then the rate of lateral flow in the aquifer, using the same porosity and hydraulic gradient, can be calculated by applying Darcy's Law to flow within a porous medium. The equation for velocity becomes

(Reference 18):

$$V = -K\frac{dH}{dl}\left(\frac{1}{\theta}\right)x365$$

where V = velocity, m/year

K = permeability, m/day

$\frac{dH}{dl}$ = slope, dimensionless (m/m)

θ = porosity

Using this equation and the above values, the lateral velocity would be:

$$(10\ \text{m/day})x(6.2x10^{-3})x\left(\frac{1}{0.25}\right)x(365) = 91\ \text{m/yr}$$

$$[(32\ \text{ft/day})x(6.2x10^{-3})\left(\frac{1}{0.25}\right)x(365) = 290\ \text{ft/yr}]$$

The only well along Lost Creek which may be alluvial is Well 6. This well is listed in the Colorado State Engineer's driller's log as an alluvial well, however, in light of its location and water level depth, this well may actually tap the bedrock (Reference 22). The well is located about 2260 m [7390 ft] from the northeast corner of the site. At the above flow rates, the time required for leachate to first reach the well is:

$$\frac{2260\ \text{m}}{91\ \text{m/y}} = 24.8\ \text{yrs}$$

North-Northwest Flow Rate - -

Approximately one-third of the leachate in the unconsolidated sediments would flow to the north-northwest along Horse Creek. The surface gradient in this direction appears to be about $6.9x10^{-3}$ from the U.S.G.S. 7-1/2 minute topographical map. If this value is assumed for the hydraulic gradient and all other values are as above, then the flow rate would be:

$$(10\ \text{m/day})\times(6.8\times10^{-3})\times\left(\frac{1}{0.25}\right)\times(365) = 99\ \text{m/yr}$$

$$[(32\ \text{ft/day})\times(6.8\times10^{-3})\times\left(\frac{1}{0.25}\right)\times(365) = 318\ \text{ft/yr}]$$

The Colorado State Engineer's office and the U.S.G.S. have no record of any alluvial wells located along Horse Creek within 6.5 km [4 mi] of the drying site. There are several alluvial wells along Box Elder Creek to the west of Horse Creek (Wells O, P, Q, and U on Figure 5). This creek is separated from Horse Creek by a ridge which will in all probability prevent any alluvial groundwater from flowing from Horse Creek alluvium into Box Elder Creek alluvium. Apparently, then, the more critical alluvial aquifer is that along Lost Creek, and should be monitored more carefully.

Leachate Flow in Bedrock

Since most of the wells in the immediate vicinity of the site tap the bedrock aquifer, the rate of flow into this aquifer is important. Flow within the bedrock will be both vertical and lateral, with lateral flow rates generally greatly exceeding vertical rates.

Lateral Flow Rate - -

No data exist on the permeability of the bedrock beneath the site. Data do exist for bedrock of the Denver and Dawson formations at other locations in the vicinity of the Lowry Bombing Range (Reference 16). The hydraulic conductivity of six samples from the upper bedrock formation near Lowry range from 2.9×10^{-5} to 2.7 m/day [9.4×10^{-5} to 8.7 ft/day], with a mean of 0.86 m/day [2.8 ft/day] (Reference 16). The mean porosity was 41.4 percent. Water-level measurements in the wells tapping the bedrock aquifer near Site B-2 indicate that the groundwater flows in the same general direction as do surface waters; that is, to the north-northwest along Horse Creek and to the north-northeast along Lost Creek (Reference 23). The hydraulic gradient is about 4.7×10^{-3}. The lateral rate of groundwater flow using the mean hydraulic conductivity given above is then:

$$(0.86\ \text{m/day})\times(4.7\times10^{-3})\times\left(\frac{1}{0.414}\right)\times(365) = 3.6\ \text{m/yr}$$

$$[(2.8\ \text{ft/day})\times(4.7\times10^{-3})\times\left(\frac{1}{0.414}\right)\times(365) = 11.6\ \text{ft/yr}]$$

Vertical Flow Rate - -

The rate of vertical water flow in saturated materials is controlled primarily by the stratum having the lowest vertical hydraulic conductivity and greatest thickness. Siltstone in the upper part of the bedrock formation probably has the lowest hydraulic conductivity. Again using data from the Lowry study since none is available at Site B-2, the vertical flow rate can be estimated. In the Lowry study the vertical hydraulic conductivity was estimated to lie midway between the mean and minimum lateral hydraulic conductivity, or $4.9\text{x}10^{-3}$ m/day [$1.6\text{x}10^{-2}$ ft/day]. The head difference at Lowry was estimated from well data to be about 2.0 m [6.5 ft] across a zone about 50 m [160 ft] thick consisting primarily of siltstone. A porosity of 41.4 percent was again assumed. Using these assumptions, the vertical flow rate is then:

$$(4.9\text{x}10^{-3}\ \text{m/day})\text{x}\left(\frac{2.0}{50}\right)\text{x}\left(\frac{1}{0.414}\right)\text{x}(365) = 0.17\ \text{m/yr}$$

$$\left[(1.6\text{x}10^{-2}\ \text{ft/day})\text{x}\left(\frac{6.5}{160}\right)\text{x}\left(\frac{1}{0.414}\right)\text{x}(365) = 0.57\ \text{ft/yr}\right]$$

The shallowest bedrock well in the immediate vicinity of the site is Well J at the site's northeast corner. This is a domestic well with a water level of approximately 55 m [180 ft]. At the above calculated vertical velocity, the time required for leachate to first reach this well is:

$$\frac{30\ \text{m}}{0.17\ \text{m/yr}} = 323\ \text{yrs}$$

Discussion

The preceding calculations of leachate flow rates through the unconsolidated and bedrock aquifers should be considered order-of-magnitude estimates only, as they are not based on firm data from the site but on extrapolations of data from other areas. The estimates presented should represent the upper bounds of the most probable true rates; that is, the actual rates are very possible lower than those presented, but are probably not any higher. The estimates are presented to give some idea of the time frame in which evidence of groundwater pollution is likely to first be noticeable in existing wells in the area.

On the basis of the soil data obtained at the site, it appears that the more permeable sediments and bedrock are on the western rather than the eastern side. This means the leachate flow in the unconsolidated sediments along Lost Creek will be much slower than the flow along Horse Creek. There are no wells tapping the alluvium along Horse Creek within 6.5 km [4 mi] of the site. There apparently is an abandoned alluvial well within 2260 m [7390 ft] of the site along Lost Creek.

The greatest potential for groundwater pollution appears to be in the bedrock beneath the site. Most of the wells shown on Figure 5 are bedrock wells. It is impossible with the available data to predict the extent to which deterioration of the bedrock aquifer will take place. A more accurate assessment of this potential will be possible after the beds have begun operation. A monitoring program will be set up to determine actual rate of leaching from the beds and direction and extent of leachate flow.

Groundwater Monitoring Program

The U.S.G.S. has submitted a proposal for monitoring groundwater in both the unconsolidated sediments and bedrock beneath the site. This proposal is presented in Appendix D. The proposal calls for drilling twenty-nine onsite and five offsite wells for monitoring any water in the unconsolidated, or alluvial, sediments. Six wells will be drilled for monitoring the upper 30 to 60 m [100 to 200 ft] of bedrock groundwater. In addition, six pan-type lysimeters will be installed under selected drying basins to determine rate of leachate movement and to monitor leachate quality. It is also planned to monitor as many as possible of the existing wells within a three-mile radius of the site. EPA thinks that more monitoring of the unconsolidated flow should be done in the initial stages of the project. Additional multi-stage vacuum lysimeters should be used; once a better idea of the kind of groundwater movement is obtained, well placements could be made.

This program with subtle modifications will allow a fairly accurate assessment of the effects on groundwater quality by the sludge drying project. Evidence of potentially serious contamination problems should become evident long before a serious problem develops. If such indications appear, appropriate mitigative actions would be taken. This would include lining the basins with a completely impervious liner, installing a leachate collection system, or as a last resort, ceasing drying operations altogether. EPA will require submission of a comprehensive groundwater monitoring program plan to be submitted in time for at least six months of data collection prior to project implementation (see Grant Condition #3f).

Groundwater Quality Implications

Approximately 77,000 m^3/yr [62 acre-feet or 2.7×10^6 ft^3/yr] of free water associated with the sludge drying operation are predicted to move through the unconsolidated materials beneath the site toward permanent groundwaters each year with the suggested lining measures.

The principal constituents of concern would be soluble species, primarily TDS and nitrates. EPA has little doubt that suspended solids, heavy metals, bacteria and viruses will be effectively removed and contained in the soil medium by adsorption, ion-exchange, and filtration processes. Therefore, further discussion will focus on these two species -- TDS and nitrates. EPA is concerned that drinking water standards be maintained in the regional groundwater supply.

Nitrates. - Nitrates pose the most serious hazard to drinking water supplies. Drinking water standards call for an upper limit of 10 ppm nitrate (as N) in order to protect against the possibility of methaglobanemia, a disease affecting newborn and infant children. Nitrate contamination is a problem in the lower reaches of the Lost Creek Groundwater District. This is believed to be caused by leaching of applied fertilizers on irrigated lands, which predominate in the lower reaches of the Lost Creek basin. For this reason, the Lost Creek Groundwater District has opposed this project (see Letter #44), citing the dangers threatening domestic users of this groundwater supply from a cumulative buildup of nitrates in the groundwater. Presuming that nitrate pollution is directly related to irrigated agriculture, there is little reason to believe that there is any current nitrate problem in the groundwaters beneath site B-2. Under this assumption, background nitrate concentrations should be near zero. This assumption can be tested when the U.S.G.S. is allowed to develop pre-project groundwater monitoring.

Metro's test data at the Greeley drying site has indicated nitrate concentrations in the range of 20-200 ppm as N as instantaneous concentrations. Assuming a long-term average concentration of 100 ppm of nitrates in the percolating waters from the sludge operation, and a 60 acre-foot per year leaching rate, a rough order-of-magnitude estimate of the groundwater nitrate concentration can be made. Further assuming a background nitrate concentration of zero, a 2" precipitation recharge rate, and approximately 250 acre-feet/year of groundwater crossing the site (Reference 14), a concentration of nitrates in the groundwater leaving the site of 9 ppm would be predicted. This is in the vicinity of the 10 ppm standard. Further mixing would reduce the concentration in the area.

EPA does recognize that there will be some impact of increased nitrates in the vicinity of the site, even with the proposed mitigating measures. EPA will insist that concentrations of nitrates leaving the site B-2 boundary be maintained within the 10 ppm standard. The cumulative impact can be stated in terms of total tons added to the groundwater. With the predicted rates and totals, about 8.5 tons of nitrates per year would be added to the groundwater. Were the B-2 site under irrigated agriculture, a rough order-of-magnitude estimate of the leached nitrogen (based on current practices) would be about 40 tons per year, from a 2000 acre site. The estimated concentration would be about 20 ppm nitrate as N. The total cumulative impact of the sludge operation would be about 1/2 that of an irrigated field of the same size.

TDS -- Similar calculations can be made for the effect of the added salts from the proposed sludge drying operation. Draft EIS estimates of TDS in sludge were as high as 6000 ppm (early Metro data). More recent data from Metro (see discussions under Issue V-1) indicates that salt concentrations would be nearer 2-3000 ppm. Assuming a salt loading of 3000 ppm and a natural background of about 400 ppm TDS, the expected concentration of TDS in the groundwater would be about 640 ppm. This would add about 245 tons of salt per year into the groundwaters of the area. This should be considered to be an insignificant increase; the 40,000 acre-feet of water drawn from the Lost Creek aquifer each year (assuming a 400 ppm TDS) contains some 21,800 tons per year of salts. Drinking water standards would not be significantly affected by this increase, except perhaps for isolated wells. Further pumping by Metro could reduce the amount of salts carried off site beneath Site B-2 if a problem were identified.

Since these calculations are quite tenuous, Metro will be required to submit a contingency plan to pump out contaminated water in the event of a drinking water quality standards violation. County and State Health Departments will receive data periodically from Metro and will determine the need for mitigation (see Grant Conditions #3e and 6).

ISSUE II-3. Will odors create a problem in the vicinity of the site either from normal operations or with digester upsets?

Concern for potential odor problems near the site has been expressed by a number of nearby residents in letters to EPA on the draft EIS. Foul odors emanating from Barr Lake in the past and from the earlier Lowry disposal site operations are cited as evidence that such odors will be emitted. However, anaerobically digested sludge has little odor (most of the sludge disposed at Lowry is not digested). No situation analogous to that which occurred at Barr Lake in the past should exist with the present project. If a digester upset occurs, planned standard monitoring of digesters will alert operators to the existence of the problem before sludge is released to the pipeline. Proper corrective action will be taken at the plant to store the sour sludge for subsequent controlled subsurface injection. Only properly digested sludge will be transmitted to the drying bed. If, for any reason, improperly digested sludge is released to the pipeline, it will be intercepted at the site before being placed on the drying beds and will be injected into the soil at the site. This will prevent any foul odors from escaping. These procedures should prevent foul-smelling sludge from ever being placed on the drying beds. This procedure will be developed in the Operation and Maintenance Manual for this project (see grant condition #3b).

Even though properly digested sludge has very little odor, the cumulative effect of 240 ha [600 acres] of sludge exposed to the air will produce some noticeable odor. San Jose, California, currently uses about 170 ha [400 acres] of lagoons for drying its sludge. Although the current mode of operation at San Jose involves filling the lagoons with liquid sludge to depth of 4 m [13 ft], the district has used sludge depths of 45 cm [18 in] in the past (Reference 24). The plant superintendent reported that noticeable odors were produced when this method of operation was used, mainly after rainfall rewet the sludge in the lagoons which had already dried. During a site visit in late August of 1977 by EPA personnel, odors were noticeable but not objectionable. Weather conditions were slightly overcast with no rain having occurred recently, and sludge was in various states of dryness in various lagoons. The greatest source of odor appeared to be linked with freshly pumped sludge. Sludge in various states of dryness had no noticeable odor. The plant operator did report some complaints he believed resulted from rewetting of the dried sludge.

The San Jose, California basins are located near San Francisco Bay. A strong continuous onshore wind was evident during the field trip; this type of steady wind was undoubtedly responsible for carrying the noticeable odors from the newly filled sludge basins. This type of meteorological condition would bring the odors to someone directly downwind of the site for perhaps 1.0 to 1.5 km [0.5 to 1 mile]. This could create an occasional odor problem for residents in the two dwellings east and north of the site within one mile of the site boundary. Metro should be prepared to compensate the owners of these properties if the odors prove to be a nuisance. At this time, EPA cannot definitively say whether such odor potential would in fact cause a problem for these two residences.

ISSUE II-4. Will land values in the area decrease as a result of the Metro project and should Metro purchase a buffer zone to compensate owners?

As noted in the discussion of Issue II-1, the primary land use in and around Site B-2 is dryland wheat farming. Site B-2 and most of the property within a ten-mile radius of it are zoned A-2 according to the Adams County Zoning Department (Reference 12). This zoning is for agricultural use.

An appraisal of the property at Site B-2 was conducted in 1975 by a private real estate appraisal company (Reference 12). This appraisal set the fair market value of the 810 ha [2000 acre] site at about $500,000 in 1975. Although land values fluctuate somewhat, this value is expected to be more or less that the property is worth in 1977 (approximately $250/acre).

Use of this site for the sludge drying and distribution center should not materially affect the value of the surrounding land. If the center is properly operated, few direct effects will be noticed outside the borders of the site. The dryland wheat fields around the site are not in conflict with the proposed use; in fact, the fertilizer and soil conditioner value of the dried sludge may prove to be an asset to nearby land. For this reason, it is not recommended that a buffer zone larger than that already proposed be acquired around the drying beds.

According to the DRCOG land use projection for the Denver Region, it appears that no land use changes are anticipated near the site before the year 2000, with the possible exception of a regional airport. This aspect is discussed in Issue II-9.

The potential effect of this sludge drying operation on land values in the future is somewhat mixed. The value of adjacent lands will in part depend upon the projected uses. If the area continues in dryland wheat production, there is no apparent reason why the land values should rise or fall. Existing adjacent land uses should continue as before.

Should companion enterprises to the sludge drying operation be set up, the value of the adjacent lands could increase somewhat. As far as residential development is concerned, there will probably be a delaying effect on lands around the site due to the general inflationary rise in land values based on urban development speculation. As urban developments leapfrog into agricultural lands in rural Adams County, adjacent properties become desirable for additional development and hence, more valuable. Agricultural lands on the entire Denver metropolitan urban fringe are under considerable pressure from speculative buyers who are hoping to buy cheaply and sell dearly at some time in the future.

The location of a solids drying and distribution center in the rural Adams County area would probably have a retarding effect on speculative buying of adjacent lands in this area. Given other available lands, speculators would probably not buy in this area first. A number of qualifications need to be added, however.

In the first place, site B-2 is located far enough away from currently developing areas to be an unlikely candidate for near-term speculative buying. Anyone interested in a relatively quick return on investment would probably not buy in this area at present. As the metropolitan area grows, however, this situation would change.

DRCOG projections for urban growth to the year 2000 for the Denver metropolitan area indicate that site B-2 is still outside of the areas most likely to be developed. Such development is extremely difficult to predict; it is possible, however, that such growth (and its concomitant speculative buying) probably would not seriously occur until beyond the year 2000.

Another factor to be considered is the possibility of the Adams County Regional Airport being located at the site 3 km [2 mi] west of B-2 in the near future. A growth and development scenario much more rapid than pictured above could occur. It is most probable, however, that urban and commercial development would preferentially locate west of the airport, closer to the metropolitan area. The general effect of the offsite solids project at site B-2 on this development is that land values around the site might increase, but at a lower rate than either the lands to the west of the airport or if there were no sludge project.

EPA does not believe that the presence of the offsite solids project in any of the situations described above constitutes a significant detrimental impact financially to any landholders in the area. For this reason, no further mitigating measures such as acquiring a buffer zone is felt necessary.

ISSUE II-5. Will wind transport of stockpiled sludge create hazards offsite?

A potential problem with stockpiled sludge identified by various agencies is the windblowing of the sludge particles. This problem will be mitigated by proper handling procedures. When the sludge has dried to 40 to 50 percent solids, it will be removed from the drying beds by front-end loaders and piled in windrows for further drying and curing. Although the sludge will essentially be in massive form, with a high fiber content which will bind particles intimately, some particles will be loose and readily picked up by the wind. This is expected to be a very small quantity of sludge. Some pulverization will also result from transport of sludge from drying beds to stockpile areas.

During extremely high winds, the windrows will be wetted down in order to increase resistance to wind-blowing. Hydrants will be located at strategic points in the sludge stockpile area to facilitate wetting of the sludge. Water used for this operation will be plant effluent used to purge the transport system pipelines as well as runoff water from the drying and distribution site. Although this practice will moderately increase drying time, it is not expected to be necessary except under severe wind conditions. Although a very small amount of sludge will be subject to windblowing, the quantities are minor. Once the sludge has dried to 30-40 percent solids, additional wetting will not materially change the consistency of the solids. The dried material can hold the added moisture, but will probably lose the water quickly through evaporation given the large amounts of air space in the stockpiled material.

EPA will require Metro to evaluate the use of earthern berms constructed at the sludge storage area. These berms would shield the sludge from direct wind and greatly reduce the opportunity for sludge particles to be transported offsite. Metro's original design for the site called for earthern berms, but drainage was felt to be a problem. EPA would suggest that berms be placed in such a manner as to avoid creating drainage problems. Berms could be placed parallel in a north-to-south direction about 1 to 2 m [3 to 5 ft] high without seriously impeding the runoff (see Grant Condition #7).

ISSUE II-6. Is the design of the runoff retention system sufficient, especially during extreme events?

The current design of the Drying and Distribution center includes two runoff impoundment basins which will store rainfall runoff from parts of the site. One basin is located in the northwest corner of the site, and has a total storage volume of about 32,500 m^3 [26.4 acre-ft]; the other is in the northeast corner, and has a volume of about 79,500 m^3 [64.5 acre-ft]. These basins will collect only runoff from areas other than the actual drying beds and sludge stockpile areas; rainfall impacting these areas will be retained and eventually evaporated.

The impounded water can either be released to downstream natural watercourses (Lost Creek and Horse Creek) or can be pumped back to the plant effluent impoundment for disposal through the crop watering systems. Before any water is discharged to surface streams, its quality must be determined to ensure acceptability.

The runoff collection system consists of grass-lined excavated drainage channels which drain to the impoundment areas. The northwest impoundment will collect rainfall from about 77 ha [192 acres]; and the northeast impoundment from about 212 ha [526 acres]. This area does not include the rest of the site exclusive of the basin and stockpile area; some rainfall hitting parts of the site will run off to natural watercourses. However, all areas which will have sludge applied or which will be modified significantly will have the runoff collected. The areas on which runoff is not collected are generally around the edge of the site and are expected to be left essentially undisturbed as buffer areas.

The two impoundments were designed to hold the runoff from the 20 year, 12 hour storm. This event will result in a rainfall of some 6.73 cm [2.65 in.]. Any greater quantity of rainfall will result in water being discharged through a spillway in each impoundment. The spillway crest is located about 1 m [3 feet] below the dike crest, so that no water should overflow the crests under most conditions. The spillways discharge to downstream water courses. If an extreme event occurs which threatens to cause overflow of the dikes, sluice gates within transfer structures at the base of the dikes can be opened to allow a greater discharge.

The dikes proposed are earthern embankments which will be formed by material available primarily at the site. A foundation key is recommended in the design and the side slopes of the embankment will be 3 horizontal to 1 vertical.

The characteristics of the excavation and foundation material which are on the site and proposed for use in the embankment are reported in Reference 13. The report recognizes the existence of loess in the area and the fact that when wetted, the material exhibits relatively low shear strengths and is collapsable. The report further recognizes that the founding material is variable and that some local slope failures or foundation failures may take place. The specifications require excavation of the foundation key to "the lines and grades shown. The engineer may change the depth of the core trench depending on the gradation or character of the soils encountered" (Reference 25). The specifications appear to attempt to preclude any additional payment for this. Additionally the specifications point out to the contractor that additional cohesive fill may be required from an off-site location at a negotiated unit price.

In order to assure ease of administration without the problem of negotiated extra orders, it might be well to provide for a pay item for foundation key below the plan elevations shown on a unit price basis and an item for additional cohesive fill on a unit price basis. This will provide a contingency item in the bid and permit field personnel to readily administer such a contingency.

Further, during excavation and placement an experienced soils engineer should be on site or as a minimum on call with scheduled site visits to assure quality control. The specifications might also include a general statement as to what condition would require additional foundation key excavation.

The embankment and foundation stability has not been evaluated herein under the assumption that the engineer has done so given the fact that the soils problems have been identified. A more detailed soils evaluation is not warranted because the embankment failure appears to pose little or no threat to health or public safety and has no irreversible adverse environmental impacts.

Issue II-7. Should Final EIS completion await the site designation process of the County?

This issue was raised by the Adams County Board of Commissioners (Letter #40) and by others. Basically, EPA has the option of either proceeding to the final EIS in order to complete its NEPA requirements before the local site designation process is begun, or awaiting its completion before finalizing the EIS. EPA has carefully considered both options.

It is EPA's belief that the situation would be better served by first completing the EIS. This EIS process has developed a considerable amount of technical information regarding the proposed B-2 site as well as other sites. EPA has developed its own judgments as to the merits of this and other sites.

More importantly, EPA is detailing in this EIS (Appendix A of Volume II) the necessary mitigating measures in the form of grant conditions which EPA believes will minimize the identified environmental problems. This information will allow decision-makers at the local and state level to better decide whether the project with the added conditions will be acceptable.

EPA believes, based on available information, that given a few additional mitigation requirements, a great many sites could be used for this project. Similar mitigating measures would be necessary in most or all alternative sites to make the project acceptable.

The merits of alternative sites, including the present Lowry Bombing Range, have been presented under Issue IV-1. Thus the local county decision-makers will also have the opportunity to evaluate the relative prospects for locating the site elsewhere.

A final reason for proceeding with the final EIS is the extensive amount of time already consumed by this EIS preparation. EPA has taken the time to collect additional data enabling a better resolution of the issues identified in the draft EIS. EPA also feels that it has a responsibility to complete the EIS process within a reasonable length of time. We believe the resolution of the siting issue is complex, requiring much institutional cooperation among the Metro

Districts, local residents, the county and the state. EPA is concerned that awaiting resolution of this process could delay the EIS indefinitely.

EPA will not allow Step II and III design and construction funds for the project to be spent, however, until the local site designation issue is resolved. If convincing evidence for a site reevaluation is forthcoming, EPA will then prepare a supplement to the final EIS presented here.

ISSUE II-8. How does the loss of farmland productivity from Site B-2 compare with the agronomic value of the sludge?

The loss of productivity to Adams County both financially and in terms of wheat production is estimated under Issue II-11. This loss of productivity must be balanced by the gain in fertilizer and soil conditioner benefits which will accrue by the addition of some 100 mt/day [110 tons/day] of sludge to the various sites to which it is applied.

A rough estimate of the fertilizer value of sludge can be made based on the value of the sludge nitrogen content. The value of nitrogen in commercial fertilizers was estimated in Reference 26 and Appendix D of Volume I to be about $0.55/kg [$0.25/lb] in 1974. If air-dried sludge has a nitrogen content of approximately 3.5 percent, then the value of the nitrogen is:

$$1.0 \times 10^5 \text{ kg/day} \times 0.035 \times \$0.055\text{/kg} \times 365 = \$703{,}000\text{/year.}$$

$$[2.2 \times 10^5 \text{ lbs/day} \times 0.035 \times \$0.25\text{/lb} \times 365 = \$703{,}000\text{/year}]$$

Current prices for bulk fertilizer in the Denver area average between $160 to $200 per ton (Reference 27). This price is relatively insensitive to the different mixes of N, P, and K, as long as the fertilizer is high-grade (i.e., mixed in proper proportions satisfying different uses). Since the N:P:K amounts to roughly 30-40 percent of the total material by weight, the value of the nitrogen and phosphorus in the sludge can be roughly estimated, assuming sludge has about 5 percent N and P, to be about $20 per ton. At this price, the 35,000 tons of sludge dried to 50 percent solids dryness would be worth approximately $1,400,000 per year.

The actual market value of the sludge product would be substantially less, based on current prices for bulk dried sludge. Tables 8 and 9 show the values for sludge sold by municipal plants across the country (Reference 28). The authors of this publication estimate that a reasonable selling price for the sludge in bulk is $4 to $10 per

Table 8. SLUDGE DISTRIBUTION PRACTICES FOR MUNICIPALITIES
(From Literature Review[a])

Location	Year	Output[b]	Treatment	Nutrients[c]	Distribution	Price	Remarks
Amarillo, Texas	1961	na[d]	Air dried, pulverized, unbagged	na	user hauls	$3/cu yd	Annual revenue = $3000.00. Word of mouth advertising. Demand exceeds supply
Baltimore, Maryland	1961	na	head treated, granulated	N=3% P=2%	sold to jobber for delivery	$5.00-$7.50 per ton	
Battlecreek, Michigan	1960	200 tons[e]	na	N=2.8% P=2.6%	100 lb. bags	$2.00/ bag	Battlecreek Plant Food[f]
Beltsville, Maryland	1973	50 tons/day[g]	mixed with wood chips, windrowed	H_3PO_4=2.7% K=0.2% N=0.9%	municipal use only, user hauls	no charge	demand exceeds supply
Birmingham, Alabama	1960	48,000 cu hd	na	N=2.25% P=3.0%	1)ground 2)unground	1)$3.50/cu yd 2)$1.50/cu yd	still operating in 1970
Boise, Idaho	1960	200-350 tons[e]	na	N=3.59%	retail outlets	$3.15/80 lb	BI Organic[f] Farmers are largest users
Bristol, Connecticut	1960	600 cu yd	1)air dried 2)pulverized	N=2.69% P=2.52%	na	1)$1.60/cu yd 2)$.25/bushel	Sludge soil Conditioner[f]
Centralia, Washington	1961	na	open air dried some ground & bagged	na	user haul	no charge	Municipality takes loss but improves public relations
Chicago, Illinois	1975	25,500 tons	Imhoff treatment sand & gravel drying beds stockpiled	N=4% P=6% K=0.1%	24 cu yds or more delivered user load & haul	no charge	Nu-Earth[f]
Duluth, Minnesota	1960	44 tons[e]	na	N=1% P=1.5%	100 lb bags	$1.00/bag	Soil conditioner-sewage sludge fertilizer[f]

a. Source: Reference 28
b. Dry tons or cu yd per year unless otherwise noted
c. Expressed as percentage by weight.
d. Not available
e. Wet or dry basis cannot be determined for reference
f. Product name
g. Wet sludge (22% solids)

Table 8 (Continued)

Location	Year	Output[b]	Treatment	Nutrients[c]	Distribution	Price	Remarks
Enumclaw, Washington	1961	na	na	na	100 lb. bags	$1.50/bag	Population=3000 Income pays for chemicals
Fargo, North Dakota	1960	12,000 tons[e]	na	na	na	$.50/1000 lb	
Fond Du Lac, Wisconsin	1960	2,000 tons[e]	na	N=2% P=2%	1)90 lb bags 2)bulk	1)$2.00/bag 2)$18.75/ton	Fond Du Green[f]
Fort Wayne, Indiana	1960	3,000 tons[e]	na	N=2.5% P=2.5%	na	na	
Houston, Texas	1972		heat dried	N=5% H_3PO_4=4%	competitive bid, bagged for resale by contractor	$21.00/ton	Hou-Actinite[f]
Indianapolis, Indiana	1960	50 tons	na	N=5.0% P=2.7%	na	na	Indus[f]
Jasper, Indiana	1960	50 tons[e]	na	N=5.89% P=3.49%	na	na	
Kirkland, Washington	1961	na	Filter Dried	na		$3-5/cu yd $6-22/cu yd	Population 5,500 Price depends on quality
Lewistown, Pennsylvania	1960	na	Drying beds in glass buildings	na	user hauls	nominal fee	
Los Angeles, California	1973	36,000 tons	Windrow composting	N=1.0% P=1.7% K=0.01%	bought/bagged for resale by Kellogg Co.	Retail price $1.59/50 lb bag	Nitrohumus[f]
Milwaukee, Wisconsin	1968	80,000 tons	heat dried	N=2.66% P=2.18%	Distributors deal 50 lb.bags	Retail price $4.50/bag	Milorganite[f] Demand exceeds supply
Mobile, Alabama	1968	na	na		25-50 lb bags	no charge	MOBILEAID[f]
New Brunswick, New Jersey	1960	21,000 tons	na	N=1.7% P=2.18%	na	na	downward trend reported in 1960
Oklahoma City, Oklahoma	1960	na	na	na	sell at beds for $1/ton	na	still operating in 1970
Omaha, Nebraska	1960	500-600 tons[e]	na	N=2.5% P=1.5%	1) bulk 2) bag	1)$15/ton 2)$1/100 lb.	still operating in 1964 distribution through contractor
Oshkosh, Wisconsin	1960	600 tons[e]	na	N=2.09% P=2.65%	sold locally from plant	$0.25/cu yd $2/cu yd ground	Oshkonite[f]

Table 8 (Continued)

Location	Year	Output[b]	Treatment	Nutrients[c]	Distribution	Price	Remarks
Pennsauken, New Jersey	1960	200 tons	na	na	na	na	
Roanoke, Virginia	1960	1,688 tons[e]	ground & unground	N=2.5% P=1.5%	1)80 lb bags 2)bulk	1)$2/bag 2)$18.75/ton	
San Diego, California	1970	na	mixed with seaweed and leaves, air dried	na	Park Dept.	not for sale	All is used for Mission Bay Development
Santa Fe, New Mexico	1960	500 tons	bagged & ground	na	100 lb bags	$2.50/bag	
Schenectady, New York	1960	250 tons	flash dried	N=2% P=2% K=0.5%	65 lb bags user hauls	$1/65 lb bag	ORGRO[f] still competing in 1970
Seattle, Washington	1961	na	air dried	na	city use only	no charge	
Sheboygan, Wisconsin	1960	1000 tons[e]	na	N=1.96% P=1.65%	bar or bulk	$.50/80 lb $5.75/ton	
Springfield, Illinois	1960	na	air dried	na	user haul	no charge	main users-farmers, park board, golf courses
Vancouver, Washington	1961	na	glass covered drying beds	na	80 lb bags	$2.50/bag	
Wichita, Kansas	1961	5000 cu yd	na	N=2.1% P=0.2%	1)user haul 2)delivered	1)$2/cu yd 2)$3-4/cu yd	Wichita Soil Conditioner
Winston-Salem, North Carolina	1971	na	Digested, air dried then flash dried in rotary unit	na	bulk or in 50 lb bags	$30/ton bulk $1.05-1.95 bagged	Operating since 1958

Table 9. SLUDGE DISTRIBUTION PRACTICES FOR MUNICIPALITIES
(From Telephone Review)

Location	Output^a	Treatment	Distribution	Price	Nutrient	Dates of Operation	Remarks
Amarillo, Texas	2,000	air dried on land and sand beds heat dried by Relco	Kentucky & Tennessee	na^b	N=2-3% P = 2% K = 0	1960 - now	air dried sludge sold to Relco Inc. for $1/ton
Birmingham, Alabama	na	1)flash dried 2)air dried	user hauls 1) bagged 2) bulk	1)$1.50/lb 2)$1.50/cu yd	N = 1.7% P = 0 K = 0	1953 - now	Grow-Go^c private company failed so City takes loss
Corpus Christi, Texas	na	vacuum filtered rotary kiln	user hauls; bagged & sold at plant	$2/80 lb bag $10/cu yd	N = 2.5%	1936-55 air dried 1955-now vac filtered	high costs may cause shift to land application of wet sludge
Ft. Lauderdale, Florida	2,500	heat treat to 40% solid cake	dispose in landfill	free for asking	N = 0 P = 0	not really compost	may go to compost when solids increase to 50 tons/day
Houston, Texas	25,000	heat drying of activated sludge	by contract with broker	$21/ton	na	1950-now	Hou-Actinite^c
Milwaukee, Wisconsin	70,000	kiln dried activated sludge	distributor hauls	$65/ton	N = 6% P = 2% K = 0%	1925 - now	
Mobile, Alabama	45-30,000	air dried	user haul	free	na	1948 - now	market 100%
Oklahoma City, Oklahoma	na	air dried	90% landfill 10% user haul	free	N = 0.5% P = 0 K = 0	1950 - now	
Oshkosh, Wisconsin	na	air dried what could be distributed; trucked the rest to landfill	user haul	$.25/bushel $3.00/cu yd	na	1960-1972	could not distribute the dried sludge
San Diego, California	10,000	air dried stacked	park dept. uses to develop Mission Bay	not for sale	na	1960-now	private company tried to bag & sell but failed
Schenectady, New York	130	furnace dried, digested primary	user haul	$1.65 lb bag	N = 2% P = 2% K = 0	1960-1973	ORGRO^c,not much demand; losing money so not drying now
So. San Francisco California	na	wet sludge mixed with rice hulls & coffee grounds	sold in bulk to distributor	$3.00/cu yd fob $.69-.99/bag	N = 2% P = 0.5% K = 0.25%	1950-now	Tillo^c Company
The Dalles, Oregon	10 cu yd per day	air dried ground	user hauls	free	na	?-1975	now apply wet sludge on airport

a. dry tons per year
b. data not available
c. brand name of product

ton. At these prices, Metro's potential return from the marketed sludge would be in the vicinity of $288 to $900,000/year.

By comparison, the expected loss in revenue annually by use of the B-2 site for sludge production is estimated at $105,000 per year. An additional amount of net loss of about $15,750 must be added as lost tax revenue to the County (Reference 51).

Based on the above figures, the Metro operation should add value to the area economy. If Metro were to bag the dried product for small home and specialty users as is done in many other communities, a ton of dried sludge product could sell for as much as $40 to $60/ton (Reference 28). This would create a market value of perhaps 3 million dollars per year, although the extent of market demand would limit how much of the material could be sold in the bagged form. Metro could also work in conjunction with a fertilizer distributor to fortify the dried sludge to high-grade quality fertilizer; this would result in a much higher value operation. Metro has been investigating this possibility although it is very preliminary at this point (Reference 29). In California, for example, Los Angeles County sells its sludge compost to the Kellog Supply Company under a long-term contract. The company then retails a bagged product through K-Mart outlets, nurseries, etc.

The overall balance does appear promising to the Adams County area for future increased economic value then, in spite of the land and agricultural productivity loss at site B-2.

A number of other factors must be considered when assessing the sludge worth. First, a disadvantage of using sludge for its fertilizer value is its low density, thereby requiring the transport and application of relatively large volumes of material. This increases the handling costs. Second, sludge is not a balanced fertilizer, so supplemental fertilizers must be added to supply the potassium requirements of crops. These disadvantages are offset to some degree by the soil conditioning qualities of sludge. It is expected that addition of dried sludge to the soil will improve its moisture-holding capacity, increase its humus content, and decrease the soil's susceptibility to wind erosion. A study by the U.S.D.A. in Beltsville, Maryland, found that sludge and sludge compost applied to silt loam soil at rates of 40 and 240 mt/ha [17 and 106 tons/ac] increased its moisture-holding capacity, its cation-exchange capacity, and levels of phosphorus, nitrogen, salinity, and chlorides (Reference 30). At present, it is impossible to put a value on these various aspects of sludge use.

One final consideration when considering the fertilizer value of sludge is the likelihood that commercial sources of nitrogen will grow increasingly scarce and expensive in the future. This is directly related to the rising cost and scarcity of natural gas from which much commercial fertilizer is produced. As this trend continues, the attractiveness of utilizing the resources available in organic fertilizers will grow. Again, it is impossible to put a dollar figure on this consideration at present but it is very likely that the relative value of using sludge instead of commercial fertilizers will continue to increase. Overall, EPA believes that the effort to encourage recycling of nutrients and soil-building materials through this product will have a beneficial effect on the entire Denver metropolitan area.

Finally there is a potential savings to the Metro District of perhaps $500,000/year over the current disposal system that will make this project even more desirable.

ISSUE II-9. Are land uses in the vicinity of site B-2 compatable with the proposed Metro operation?

The present land use around the site is primarily dryland wheat farming. This use is not expected to change in the foreseeable future. This activity is quite compatable with the sludge drying and distribution site. The site requires a large amount of open space away from dense residential or commercial developments and there is an advantage to having the site near the sludge markets. Because of the wide range of potential markets, no site can be ideally located, but utilization of sludge as a fertilizer and soil conditioner on farmland is one of its major potential uses. Odors and windblowing of sludge (Issues II-3 and II-5) are not expected to be problems.

A measure of the likely conflict between the proposed sludge drying operation and future residential/urban development would be the likely rate of urban development for this portion of Adams County. The Denver Regional Council of Governments has developed a land use projection model to estimate future land uses in the Denver metropolitan area. Current projections for the year 2000 show that this area would still be largely rural. DRCOG's intention policy-wise is to maintain a 2.35 million person total metropolitan population by the year 2000, encouraging infill and development close to the existing urban areas. Other private investment decisions may well be at odds with these policies; to a great extent the Adams County Commissioners will have much to say about the future growth in this area in the next 25 or so years. The proposed use of site B-2 for a basically agricultural operation does appear to conform to the DRCOG overall land-use plan.

One potential land-use conflict which has aroused concern is the proposed Adams County general avaiation airport which may be located about 3 to 5 km [2 to 3 miles] west of the site. The primary concern is that the sludge drying beds may attract insects and birds which would be a hazard to aircraft. This problem is discussed in the next section; the conclusion is that few insects or birds will be attracted to the site. This factor, combined with the distance of the site from the airport, should obviate any bird problem. Another consideration is that commercial, industrial, and residential development may follow the airport development and be incompatable with the drying site. In general, however, it is desirable to minimize development near airports. The drying site will help provide open space and discourage development around the airport, which is an asset, not a liability.

A final possible incompatability of the airport and the sludge drying site is the generation of fog by the sludge lagoons. Fog generally is not formed in the Denver area except occasionally during the spring and fall (Reference 31). This fog usually forms in low-lying areas near water when cold fronts pass through the area. The low humidity which generally prevails effectively prevents the formation of widespread, dense fogs. However, fog will form over pools of free water under clear, cool, windless conditions. Such pools will occur at the site after fresh sludge is introduced to the beds. This type of fog generally remains directly over the beds and does not extend more than 3 to 6 m [10 to 20 ft] above the water surface. Winds in the area are less than 5 kph [3 mph] only 10.6 percent of the time; the relative humidity is above 80 percent only 13 percent of the time. For these reasons, generation of fog at the site is very unlikely to become a problem, even upon the rare occasions when it occurs.

The environmental assessment by the consulting firm CH2M-Hill indicated that a small portion of site B-2 near the southeast corner consists of a relictual prairie area. Evidently this area has not been farmed because of the drainage. EPA will discuss with the Metro District the possibility of preserving a portion of this area in its natural state. We will recommend that Metro consult with the State Division of Wildlife on the matter.

ISSUE II-10. Will insects and birds be attracted to the B-2 site and create a future hazard for airport traffic?

Insect infestation at the drying and distribution site could pose a health hazard and be a nuisance to nearby residents. A qualified entomologist has been retained by Metro to investigate and implement any necessary measures to control insect infestation at the site. With proper control, insect populations in the stockpiled sludge can be kept to a low enough level to virtually eliminate any hazards or nuisance which they might cause.

Birds attracted to the site could be a major hazard if a regional airport is located nearby. The proximity of open dumps and sanitary landfills to airports has caused serious problems to aircraft because of birds attracted to them at some areas around the country (Reference 32 and 33). A study conducted by EPA's Office of Solid Waste Management Program found that the attractiveness of such sites was directly related to the availability of food, water and, to a lesser extent, suitable shelter (Reference 32). By converting open dumps to sanitary landfills, availability of food and water is reduced, and the bird problem is consequently lessened. The study did not consider sludge drying beds; however, the conclusion that food availability is a major attractant implies that the Metro Denver site would not be particularly appealing to birds. The only food source which might be available at the site is insects, which will be kept to a minimum by proper control. The intermittent existence of free water on the drying beds when sludge is first introduced may be something of a bird attractant, but this aspect is felt to be secondary to the availability of food and is not expected to attract many birds. The experience of smaller sludge drying bed operations and of the San Jose sludge lagoons has been that birds and insects are not attracted to this type of environment.

A similar issue has been raised with a newly constructed wastewater lagoon near an existing airport near Boise, Idaho. Pilots have become concerned that just the presence of open water could pose an attractant to migrating birds.

There always is the possibility that some birds could be attracted by the particular facility and result in a bird-airplane strike. However, every other open water pond or reservoir would create a similar hazard. EPA does not believe at present that there is sufficient evidence to indicate that birds would be attracted in significantly large numbers to the sludge drying site. Near Travis Air Force Base in California, for example, a 120 ha [300 acre] lagoon was recently constructed. The Air Force did insist upon steep-walled sides for the lagoon as well as weed control, to minimize the potentially available food for aquatic birds. Many of America's largest airports are located very close to productive bodies of water (San Francisco Airport, Logan in Boston, etc.). It does not appear that the mere presence of the sludge drying beds and associated reservoir located at a distance of some 3 to 5 km [2 to 3 miles] from the potential airport can be considered an immediate or unnecessary hazard to aircraft. EPA will require Metro to utilize weed control on the reservoir as well as the rest of the site to minimize the attractive potential to birds (see Grant Condition #8).

ISSUE II-11. Is this project of such an untested nature as to require further research before the project should be implemented?

Concern has been expressed that the current project is not feasible or at least is untested. However, most aspects of the proposed system have been widely used by other agencies, on smaller scales and with minor variations. Pumping of liquid sludge is a common practice, and use of the most up-to-date engineering design and practice (Reference 34) will enable a reliable and safe pipeline to be built and operated. Sludge drying beds have long been widely used, and their design principles are well known. Dried sludge has been fairly widely used as a soil conditioner/fertilizer with great success under a number of conditions and after various types of treatment (see Tables 8 and 9 under Issue II-8 which identifies municipalities across the country marketing or distributing various forms of processed sludge to agricultural users).

It is true that most other drying bed/soil conditioner systems used by other plants have been much smaller in size than the proposed project. Obviously, then, this variable cannot be tested any further, but there is no reason to believe that the proposed project is too large.

In comments on the draft EIS, the following areas were identified by individuals or agencies as being areas of unknowns or uncertainty that might require further research:

a) soils and groundwater data to assess impacts at the site;
b) the "success" of the project in terms of developing a market;
c) the effects of sludge applications on dryland farms;
d) testing to determine the value of the fertilizer content;
e) proper application rates of sludge and heavy metal accumulations in the human food chain;
f) sludge injection requirements during winter months;
g) long-term soils productivity;
h) the method of operation at the site (drying times, loading rates, etc.);
i) the best kind of digester performance (mesophilic vs. thermophilic);
j) research on industrial pretreatment;
k) heavy metals toxicity to plants;
l) the means of controlling sludge applications.

Some of these are genuine research areas; others already have research data available. Each will be discussed in turn.

a) Soils and groundwater data are now available and are discussed under Issue II-1 and II-2. Further data would not be essential at this point in time; it is believed Metro can adequately protect the groundwater with the proper lining techniques.

b) "Success" can only be determined after the project has been in operation. Other similar operations (see Issue II-8) indicate success can be achieved.

c) A genuine research issue is the practicality and feasibility of using sludge on dryland farms. These farms can tolerate only a low level of fertilization; however, since the fertilizer content of the sludge is known, application rates of sludge can be kept within the limits which the dryland soil can accommodate, and no problem should ensue. In fact, it is quite possible that the output of dryland farms will be improved because sludge increases the moisture-holding capacity of the soil. In any case, if signs of over-application appear, sludge use can be discontinued on dryland farms. Sludge has been used with no harmful effect in several irrigated or high-rainfall situations, and its use on irrigated farms has been proved beneficial (References 38 and 35). The same is true for parks and grass areas. Metro currently does not expect to supply much sludge to dryland farms; irrigated farms, sod farms and municipal parks would preferentially receive the sludge. The research and demonstration areas on site could be used to test the value of using sludge on dryland operations.

d) The fertilizer content in sludge is readily known; the actual effect of using sludge can only be appraised by in-the-field experience. There is considerable country-wide research and practical experience to indicate the beneficial impact of using sludge (see (e) below).

e) The Metropolitan Sanitary District of Greater Chicago is currently using sewage sludge to reclaim strip-mined land in Fulton County, Illinois (Reference 36). The district intends to grade the land to control runoff, increase the soil humus by the addition of sludge and restore the land to full productivity. Eventually, some 2,898 ha [7,156 acres] is to be reclaimed. In 1972, 108 ha [268 acres] received 661 mt [729 tons] digested sludge. Operations continued in 1973, 1974 and 1975 with 27,500 mt [30,388 tons] of solids being applied to 695 ha [1,713 acres] in 1975. This is a loading rate of 39.6 mt/ha [17.7 tons/acre]. The sludge is applied in liquid form, being either sprayed onto the land or injected into the soil.

The district conducted a four year monitoring program from 1971 to 1974 to assess the impacts of the project on surface and groundwater, on crops grown at the site, and on soils. Conclusions from the program include: (1) surface waters in streams receiving runoff from the site have been unaffected by the sludge application; (2) groundwater monitoring wells near the site show no evidence of groundwater contamination; and (3) after three years of sludge application, metal levels in corn grown on sludge-amended soils show no significant increase (Reference 36).

The Council for Agricultural Science and Technology (CAST) has recently reviewed the potential problems, limitations, and constraints which should be considered when applying sludge to land (Reference 38). The basic conclusion of this report is that the potential exists for harm, but with proper management and monitoring, adverse effects can be minimized or avoided. The study recommends various procedures and monitoring programs which should minimize the chances of adverse effects from sludge use on crops.

Enough data is available to indicate that the proposed Metro project should be allowed to proceed if certain precautions are taken. Monitoring of groundwater at the site is discussed in Issue II-2. Rates of application of sludge to soils should be limited to that quantity which supplies sufficient nitrogen for plant growth. This generally results in application rates of from 5 to 40 mt/ha [2.2 to 17.8 tons/acre] (Reference 38). This rate should limit the application of potentially toxic metals to levels that are of no concern except with sludges having excessively high metal content. To assess long-term metal accumulation, the soils on a representative tract of land receiving the highest sludge loading recommended should be sampled every five years to determine metal content. If significant increases are found, sludge application could be discontinued or reduced as needed.

f) Metro does not now plan to apply sludge during winter months. The basin capacity includes three months of storage for winter months. Metro's research and demonstration areas could be used to test wintertime applications.

g) While there is no formal long-term soils productivity study available for sludge use, sludge applications on soils for the last 10 to 15 years do not indicate any drastic effects. Such a research effort would require cessation of land application of sludge nationwide for perhaps 25 to 50 years. EPA does not believe the potential hazards so far indicated warrant such a drastic moratorium.

h) Many of the unanswered questions about on-site operations could best be resolved through actual operating experience. EPA believes that once it has been established that the Metro project is reasonably designed and will work based on best available information, there is no reason to further delay the project. The discussion under Issue II-12 argues that drying capacity appears satisfactory; Metro's Greeley test data indicate that sufficient drying of sludges similar to Metro's has occurred in shorter times than the project design calls for.

i) The best form of digester performance is also a potential research area, but one that can be done after project implementation. Metro is interested in testing the thermophilic mode of digester operation as a research effort. The success of the project is not dependent on the outcome of such research, however.

j) Industrial pre-treatment to lower heavy metal content in Metro sludge will be ongoing. EPA national policy now is to require industrial pretreatment where it is practical. Since the heavy metal concentrations in Metro sludge are relatively low, the success of these further removals will not affect the overall design of the solids drying project.

k) Heavy metals toxicities to plants are being extensively investigated by various institutions such as agricultural colleges, the U. S. Department of Agriculture and others around the country. Valuable corroborative and area-specific data could be achieved if Metro District were to conduct similar research experiments on plant toxicity on the drying site.

l) Means of controlling sludge application is a current institutional problem, but one under consideration now by the State of Colorado (see Issue V-4). Reasonable application rates and requirements for applicators and distributors will be part of the regulations being developed by the State. While proper rates may have to await actual experience, it is believed that conservative estimates are being incorporated into these regulations. The Metro experience will be valuable in setting future standards for other municipal operations of the same kind.

It is EPA's belief that none of the areas of needed research cited above are obvious or alarming enough to require delay of this project. To the contrary, going ahead with this project will provide some valuable answers to the research questions posed for the semi-arid Colorado situation.

ISSUE II-12. Is the drying bed capacity sufficiently designed?

The drying beds have been designed to handle the 1985 sludge production from both the Denver Northside and MDSDD#1 plants. This is expected to be 151 mt/day (160 tons/day) before digestion and 100 mt/day [110 tons/day] after digestion (Reference 26). The liquid sludge from the digesters will be pumped to the site at a solids concentration of approximately 2.8 percent, resulting in the transport of some 3470 m^3day [917,000 gal/day] of water to the site. Plant effluent used to periodically flush the sludge pipelines will raise the total to about 4160 m^3/day [1.1 mgd].

At the site, 243 ha [600 acres] of drying beds will be used to dry the sludge to about 40 to 50 percent solids. The total volume of water which needs to be removed annually if the sludge is dried to 50 percent solids is:

$$4160\frac{m^3}{day} - (1.0 \times 10^5\frac{kg}{day} \times \frac{1\ m^3}{1002\ kg}) \times 365 = 1.48 \times 10^6\ m^3/yr$$

$$[1.1 \times 10^6\ \frac{gal}{day} - (2.2 \times 10^5\ \frac{lb}{day} \times \frac{1\ gal}{8.34\ lb} \times 365 = 3.92 \times 10^8\ gal/yr]$$

To this quantity must be added the rainfall which impacts the beds during drying. The average rainfall in the area is estimated to be about 300 mm/yr [12 in/yr] (Reference 26). The evaporation rate required to evaporate this quantity of water from 243 ha [600 acres] is:

$$1.48 \times 10^6\ m^3/yr \times \frac{1\ ha}{10^4\ m^2} \times \frac{1}{243\ ha} \times \frac{10^3 mm}{m} + 300\ mm = 910\ mm/yr$$

$$[3.92 \times 10^8\ gal/yr \times \frac{1\ ft^3}{7.48\ gal} \times \frac{1\ acre}{43{,}560\ ft^2} \times \frac{1}{600\ acres} \times \frac{12\ in}{ft}$$

$$+ 12\ in/yr = 36\ in/yr]$$

If this quantity of water must evaporate within nine months to allow three months storage of dried sludge in the beds, then the evaporation rate must be:

$$910\frac{mm}{yr} \times \frac{1}{0.75} = 1200\frac{mm}{yr} \qquad [36\frac{in}{yr} \times \frac{1}{0.75} = 48\frac{in}{yr}]$$

The above calculations are conservative because some water is lost by percolation, and a sludge dryness of 40 percent instead of 50 percent is acceptable. However, these quantities of water are small in comparison to the total. Evaporation rates in the area are estimated to range from 927 mm/yr [36.5 in/yr] to 1524 mm/yr

[60 in/yr] (References 15, 26, and 37).

On the basis of these calculations, it appears that sufficient capacity is available at the site to dry the sludge. These calculations are valid only if careful operating procedures are followed. Most importantly, a sludge crust on the surface of the drying sludge must not be allowed to form. If it does, drying may be greatly inhibited. Crusting apparently is more of a problem when water is lost by evaporation rather than by percolation. Metro has indicated that breaking up of a sludge crust on the surface will be a routine operating procedure. Another factor is that surface runoff must not be allowed to enter the beds; also, during wet years, drying times may be extended beyond those predicted.

The estimates for drying times presented herein will be refined once actual operation has begun. Tests conducted by Metro at the Northern Colorado Research and Demonstration Center at Greeley, Colorado, indicate that faster drying times may actually be achieved. Tests were conducted using four 30 m x 30 m [100 ft x 100 ft] earthern drying basins similar to those to be constructed at the proposed drying site. Two types of sludge were used, an anaerobically digested primary sludge from the Denver Northside Plant, and an anaerobically digested mixture of primary plus secondary sludge from Ft. Collins, Colorado. These two sludges are expected to closely represent the type of sludge that will be dried at the proposed site. Both sludges were found to have similar drying rates. The sludges were loaded on the beds at depths of 25, 76, and 61 cm [10, 31, and 24 inches] and were allowed to dry to a 60 percent solids content. The 25 cm [10-inch] loadings dried within 95 to 96 days, the 76 cm [30-inch] loading dried within 149 days, and the 61 cm [24 inch] loading dried within 117 days. These drying times are considerably quicker than those that would be predicted based on the assumptions contained herein. However, it must be noted that leaching rates in the initial days of drying were considerably higher than those that will occur at the center with lined beds. The quantity of water leached was not great compared to the quantity evaporated on the beds loaded at 61 and 76 cm [24 and 30 inches].

ISSUE II-13. How soon will additional capacity be required at the sludge basins, and will more land be required?

The assumptions of the preceding section provide an estimate of the maximum quantity of sludge which could be dried at the site. Using the average value of the evaporation rate, and keeping all other values the same, the quantity of sludge (in terms of dry weight) which could be dried at the site (with a 9-month drying time) is:

$\frac{1225}{1200}$ (100 mt/day) = 102 mt/day [$\frac{48}{48.3}$ x (110 tons/day) = 111 tons/day]

This quantity is the predicted ultimate capacity of the sludge drying beds.

Predictions of future sludge loads are difficult to make accurately mainly because of the difficulty in predicting future population. Estimates of the future Denver regional population in the year 2000 contributing to Metro's sludge load vary from 1,981,000 to 3,399,000 residents. (See Table 13, Volume I of the EIS). EPA's policy has been to support no greater than the DRCOG policy growth rate of 2,350,000 persons by the year 2000.

The design for this project is based on a projected sludge load of 151 dry mt [166 dry tons] per day by the design year 1985. This projected value has been adopted from the 1972 CH2M-Hill report entitled: "Metro Denver: Sewage Treatment Plant Expansion." (Reference 50). At that time the Denver metropolitan area was growing at 4 to 5 percent per year. Using a value of 0.06 kg [0.13 lbs] of solids generated per day per person, the 151 mt [166 tons] per day is equivalent to a population of 2,550,000 persons for the year 1985 that would be serviced by this Metro facility. Since then the metropolitan area growth rate has slowed to a 2 to 3 percent per year increase. Assuming a 2.5 percent compound increase in population (the DRCOG policy forecast rate for the Denver metropolitan area), the current Metro District population of about 1,000,000 persons would increase to only about 1,280,000 persons by 1985.

Because of anaerobic digestion that reduces the total mass of generated sludge by about 35 percent, the actual sludge generated for pumping to the offsite solids area would be reduced by a third or so. Based on the above assumption, Table 10 indicates the population, sludge generation, and sludge to be pumped to the offsite solids area for the years 1977, 1985 and 2000.

Table 10. PROJECTED SLUDGE QUANTITIES PRODUCED BY METRO FOR THE YEARS 1977, 1985, and 2000.

Year	Population of Service Area	Sludge Generated (mt/day)	Sludge Generated ([Tons/Day])	Sludge to Basins (mt/day)	Sludge to Basins ([Tons/Day])
1977	1,000,000	89	[98]	61	[67]
1985	1,800,000	106	[117]	71	[78]
2000	2,350,000	138	[152]	94	[103]

If growth occurs at rates higher than the predicted DRCOG rate, the drying beds might not have sufficient capacity to handle the year 2000 sludge flows. EPA will be determining air quality criteria to insure that growth rates are compatible with air quality problems. Even if the median predictions given in Volume I, Table 12 of 2,780,500 residents were reached in the year 2000, the year 2000 sludge quantity would be 161 mt/day [177 tons/day]. This is a slightly larger quantity of sludge than the beds are predicted to be able to handle by the year 2000.

There would be several ways to increase the capacity of the drying beds without increasing their size. First, the sludge could be pumped to the site at a solids concentration of up to 4 percent rather than at 2.8 percent as presently envisioned. This will involve a certain amount of sludge thickening at the plant, with return of supernatant to the treatment works. This will increase the load on the treatment plant. Using a 4 percent solid concentration instead of a 2.8 percent solids sludge will reduce the water content by 34 percent, which effectively increases the bed capacity by 50 percent. Another technique is to decant the free liquid on the top of recently loaded beds and use this liquid for irrigation, dust control, etc., at the site. This technique will not be feasible if good solids/liquid separation does not occur in the beds. Pilot studies conducted by Metro on digestion of a 50-50 mixture of secondary waste activated and primary sludge indicate that solids/liquid separation does not take place (Reference 1). However, chemicals could be added if desired to improve separation.

If, at some future date, more bed capacity is required, then more drying beds could be constructed using another portion of the 810 ha [2000 ac] site. This may require a loss of some research and demonstration areas. It is likely that this alternative would be preferable to acquiring more land around the site. The calculations and possible mitigating measures discussed here indicate that bed expansion will probably not be necessary before the year 2000.

ISSUE II-14. Is Site B-2 at such a distance from potential markets as to affect sludge marketability? Is there an optional site elsewhere?

At present, Metro plans to dispose of its final dried sludge product through the following markets: (1) Denver parks, (2) sod farms, (3) mine spoil sites, (4) irrigated farms, and (5) dryland farms. Each of these users is discussed in Section IV of Volume I. In Section V of Volume I the relative fertilizer value of the sludge nitrogen is calculated and compared to the energy cost of sludge transportation. Using a cost of \$0.08/m^3-km [\$0.10/yd^3-mile], the break-even trucking distance was determined to be almost 100 km [60 miles]. A large amount of farmland acreage is within this distance of the drying/distribution center, as are sod farms and Denver parks. However, this calculation should be considered with caution, because of many factors affecting the actual present and future value of the sludge (see discussion of Issue II-8).

Because of the geographic diversity of potential markets, it is impossible to select a site ideally located with respect to all of them. Site B-2 is midway between the sod farms. It is 13 to 32 km [8 to 20 miles] away from the large irrigated farming areas along the South Platte northeast of Denver. It may be somewhat distant from the municipal market (32 to 48 km [20 to 30 miles]). A slightly more favorable location closer to Denver from a market standpoint would put the site into conflict with the urbanizing areas. The B-2 site is approximately 13 km [8 miles] away from a railroad siding near Manila. The site is also favorably located with respect to the suggested Watkins strip-mining/gasification project.

EPA does not think a relocation of the site is justified on market grounds, unless one of the potential uses were likely to predominate. We have no evidence to indicate that this is the case. As explained elsewhere (see Issue I-6), Metro is considering storing some anaerobically digested primary sludge on the Commerce City plant site for Denver parks use. This would help relieve the burden of a 30-mile one-way trip to obtain sludge for city parks.

ISSUE II-15. What are Metro's plans for emergency disposal of sludge if the markets do not develop as expected?

If a market for the sludge does not develop as expected, Metro plans to temporarily store it onsite and, if necessary, dispose of excess sludge by landfilling at the Lowry site. Metro estimates that some 283,000 m^3 [1.0 x 10 ft^3] of storage space is available onsite for storage of dry sludge. Assuming a density of 560 kg/m^3 [35 lbs/ft^3] for sludge with a 50 percent solids content, this is enough storage for approximately two years at a production rate of 100 mt/day [110 tons/day] of dry solids.

In the event that landfilling of the dried sludge becomes necessary, the sludge will be trucked to the Lowry landfill located about 25 km [15 mi] from Site B-2. At a trucking cost of $0.08/m^3 — km [$0.10/yd^3 - mi], it will cost $3.58/mt [$3.25/ton] to haul sludge to the landfill, in addition to whatever landfilling charges are imposed.

Disposing of sludge greater than 40 percent solids which has been stockpiled for several years should pose no problems whatsoever in a well-run sanitary landfill.

ISSUE III

PRESENT OPERATION ISSUES

ISSUE III-1. Could the sludge disposal operation by Metro at Lowry be continued or modified for future use, instead of the offsite solids project?

One alternative to the proposed project is to have Metro continue to dispose of sludge at Lowry in the same manner as they are doing at present. Metro has listed the following major deficiencies in the Lowry operation:

> *"1) It is much more costly than the proposed agricultural reuse system.*
>
> *2) Because of the massive quantities of sludge disposed of at Lowry, the salt concentration in the soil has risen to the point that crop production is practically impossible.*
>
> *3) Because of the constant turning up of previously covered sludge, fly and odor problems are increasing. By incorporating the sludge to a two foot depth, hopefully, some of the salt, odor and fly problems will be alleviated through the dilution of deeper soil."*

The present operation at Lowry could continue indefinitely, but continued soil deterioration would occur. The current loading rates of 82 mt/ha [30 tons/acre] per nine month period has rendered the soils almost toxic to growth of everything but weeds in the short term.

The recent Lowry groundwater study has found evidence of some groundwater contamination in the immediate vicinity of the sludge disposal sites (Reference 16). The problem is not yet serious, but continuation of this type of operation over a period of decades may cause significant groundwater deterioration. More details of the impacts of the present Lowry operation are described in Sections VI and VII of Volume I.

Were Metro to continue using the Lowry site, it would be done so strictly as a disposal operation. Agronomic rates of sludge application have already been exceeded, and any nutrients or soil-building benefits from the sludge would simply be wasted.

From the point of view of the City of Denver, who owns the portion of the Lowry Bombing Range Metro is now using for sludge disposal, this land is dedicated as a solid waste landfill site and will eventually be used for that purpose (25-50 years). There is thus no particularly severe impact from overloading the soils on the Lowry site, since the landfill operation will also destroy the soil profile. Offsite impacts such as groundwater contamination still could affect downstream reaches of Murphy and Coal Creeks, particularly in the shallow aquifers.

In the draft EIS, alternatives were suggested for using the Lowry Bombing Range as a storage/drying area for distribution. Such a system would depend on using much the same system as at present for bringing the sludge to the Bombing Range. The critical problem with this alternative lies with secondary waste activated sludge. This sludge currently accounts for about 60% of all the sludge treated at Metro. It is a difficult substance to dewater, using expensive chemicals and energy in the process. For a successful scheme to use Lowry as a storage area, the sludge to be transported to the Bombing Range must be both relatively dry (high cake solids percentage) and stabilized (either anaerobically or aerobically digested). It has been the unfortunate experience of Metro that neither aerobic nor anaerobic waste activated sludge dewaters well. In fact, dewatering characteristics are worsened after stabilization. This means that a system involving trucking of stabilized sludge to Lowry would be extremely expensive. It does not appear to be a satisfactory long-term solution. The offsite project has the overwhelming advantages that a) the cost of pipelining the dilute stabilized sludge is relatively inexpensive and b) that the solar drying method is the only feasible way to both dewater and make suitable for agricultural use the waste activated stabilized sludge. The latter process is also much cheaper than any mechanical dewatering process.

In summary, it appears that long-term continuation of the current disposal methods or the method suggested in the draft EIS at Lowry are unsatisfactory from either an environmental or financial standpoint. The disposal method now used at Lowry is adequate for the short-term, but EPA feels that a long-term environmental goal of recycling both sewage sludge nutrients and solid wastes should be preferred.

ISSUE IV

ALTERNATIVES

Issue IV-1. Should another site for the offsite solids project, particularly the Lowry Bombing Range or the Rocky Mountain Arsenal, have been preferentially chosen?

A number of people have raised the question of why Site B-2 was chosen instead of other sites, especially ones at either the Rocky Mountain Arsenal or the Lowry Bombing Range. Metro has made repeated attempts to obtain land within the Rocky Mountain Arsenal, and has been told by the Department of the Army that no arsenal land will be made available until the demilitarization of chemical warfare agents has been completed. It appears at present that no arsenal land will be released to public use in the forseeable future as it is currently committed or scheduled to be committed to other uses. The letters in Appendix C demonstrate the consistent refusal on the part of the Army to allow the use of arsenal land for sludge drying. The use of the Lowry Bombing Range is considered further below.

Metro's consultants, CH2M Hill, did a comprehensive analysis of eleven sites in Adams County to the north and east of the central treatment plant (Reference 26). A number of factors were included in this analysis and given various weighting factors in proportion to their importance. Using this technique, the sites were given numerical ratings indicating their relative suitability for the drying and distribution center. Three sites were determined to be favored over the other eight. In a subsequent report, Volume III of the facilities plan, these sites were compared in more detail (Reference 39). This analysis led to the selection of Site B-2 as the preferred site. The selection of this site was based on the expectation that it would involve the least amount of public interaction. In other respects, notably distance from the central plant and distance from potential markets, Site B-2 was somewhat inferior to the other sites. The sites were considered approximately equivalent from an environmental standpoint. The land use aspect, however, was considered important enough to outweigh these disadvantages.

Since this analysis was performed, more data have become available allowing a better assessment of the environmental impacts of various sites. The most sensitive environmental issue is the potential impact on groundwater beneath the site from sludge leachate. Site B-2 is located in an area where impacts on ground and surface water are expected to be minimal. This is discussed in Issues II-1 and II-2. As noted in these discussions, there is no alluvial aquifer beneath the site, and the nearest alluvial well is at least 2.3 km [1.4 mi] from the eastern edge of the site. Also, the soils beneath the site are largely silty clay and clay, which are relatively impervious to groundwater flow. The few areas of more permeable sandy soils are under the western side of the site, which is in the direction of the fewest wells. Township 2S, Range 64W, in which Site B-2 is located, has the lowest average groundwater pumpage of any area within the 39,800 km^2 [15,500 mi^2] area of the Denver Basin, according to the Colorado Geological Survey. Finally, the site is on a ridge bisecting two watersheds, and therefore receives runoff only from within its own borders. The surface streams in the area are intermittent, so the potential for surface water pollution is minimal.

These results indicate that Site B-2 is in fact relatively well located with respect to minimizing water pollution, at least compared to other sites in Adams County. Most of the other factors used in the original site comparisons have not changed. It should be noted that the distance of the site from irrigated farms and sod farms is related to potential water quality problems, because these operations are in areas of high groundwater use. This increases the likelihood that leachate from the beds will contaminate groundwater supplies. Minimizing this possiblity is considerably more important than proximity of the site to these farms.

A more detailed comparison of Site B-2 with the Lowry Bombing Range is also possible with more recent data. The U.S.G.S. has recently conducted an assessment of the groundwater quality near the present sludge spreading area and the Denver landfill area at Lowry (Reference 16). This study found that subsurface conditions at Lowry are basically similar to those at Site B-2; that is, alluvium ranging up to 7.6 m [25 ft] deep overlying undifferentiated Denver and Dawson formations of mudstone, sandstone and lignite. The alluvium consists of clay, silt, sand and gravel, and is thickest along Coal Creek. The alluvium along Coal Creek also has the highest yield of water to wells, up to 38 l/min [10 gal/min]. Except for along Coal Creek, the alluvium has a small saturated thickness, fine grain size and poor sorting, and wells usually yield less than 0.4 l/min [0.1 gal/min]. This yield is still higher than the alluvium directly beneath the site B-2, which is not saturated and thus yields no water to wells.

Several observation wells tapping the alluvium in and near the sludge disposal and landfill areas were examined for evidence of water quality degradation. Five wells quite near potential pollution sources were found to have markedly degraded water quality. No evidence of groundwater degradation could be discerned from wells tapping the bedrock. The conclusion drawn from this study is that some alluvial pollution is taking place, but it has not as yet affected any bedrock groundwater. This study is also discussed in Issue II-2.

The situation at Lowry thus appears to be very similar to that at Site B-2 with respect to minimizing the potential for groundwater pollution. Any site selected for the drying center should be located in an area with minimal use of the alluvial aquifer for domestic or other uses; and preferrably on a topographic ridge so surface runoff is also minimized. Compaction of clayey materials to minimize leaching would also be required at this site.

The land ownership situation at Lowry is somewhat complex, with the City and County of Denver, the State of Colorado, the U.S. Air Force, and private individuals all owning portions of the site. If the bombing range is used, the most logical location for the 241 ha [600 acres] of drying beds would be Section 32 of Township 45, Range 65W. This land is currently owned by the City and County of Denver. This area also lies on a ridge separating two watersheds, and is the site of the present sludge spreading operation. Two intermittent streams border the site, Senac Creek on the eastern side and Murphy Creek on the western side. There are two alluvial wells used for domestic purposes less than 1.5 km [1.0 mi] from the northeast corner of this site along Coal Creek. This is considerably closer than any alluvial well is to Site B-2. Figure 6 shows the land ownership pattern near the Metro Lowry sludge spreading operation.

This site has a number of advantages and disadvantages relative to Site B-2. The advantages are as follows:

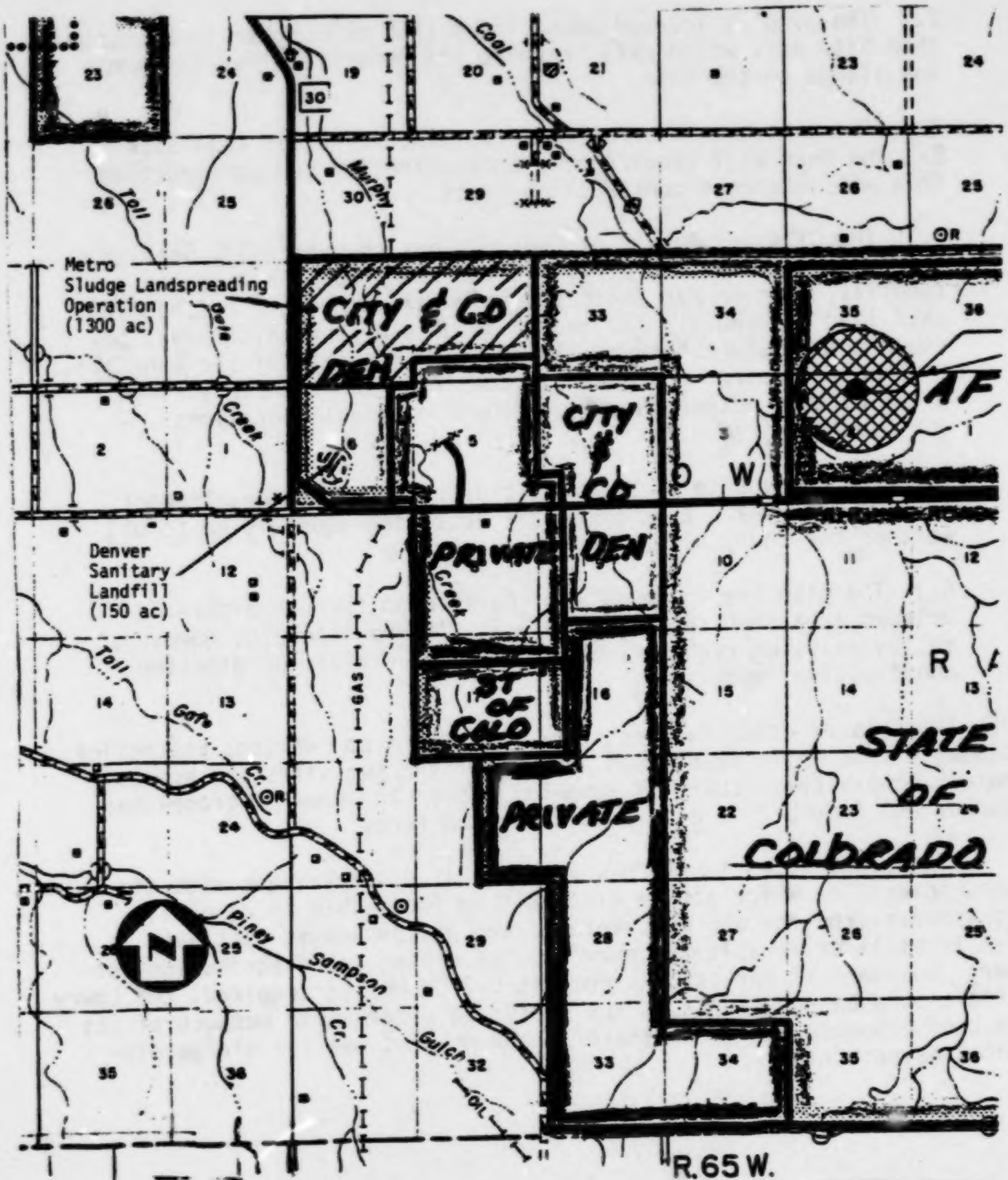
1.) The land is already being used for disposal of sludge, so a significant change in land use will not occur. Also, because of the large quantity of sludge which has been disposed at this location, the land has at least temporarily lost much of its original productivity. Construction of drying basins will therefore not represent any loss of productivity.

2.) The site is adjacent to an ongoing landfill operation, which will help limit development in the area and will obviate the need for a large buffer zone around the sludge drying beds. Also, the added attractiveness of sludge drying beds to birds will be negligible compared to that of a landfill.

3.) Most of the land is already owned by public agencies, thereby requiring less condemnation and purchase of private land than required for Site B-2.

FIGURE 6

OWNERSHIP MAP OF LOWRY BOMBING RANGE NEAR METRO DISPOSAL OPERATION


Metro Sludge Landspreading Operation (1300 ac)
Denver Sanitary Landfill (150 ac)
CITY & CO DEN
CITY & CO
DEN
PRIVATE
ST OF COLO
PRIVATE
STATE OF COLORADO
AF
R.65 W.
30
Coal
Murphy
Toll
Gate
Creek
Creek
GAS
Toll Gate Cr.
Piney
Sampson
Cr.
Gulch
Oil
O W
R

The disadvantages of this site are:

1.) As previously noted, it is not far from at least two alluvial wells used for domestic purposes, thereby increasing the potential problem from any adverse effects of bed leachate on groundwater.

2.) The site is located about 150 m [500 ft] higher in elevation than Site B-2, which will increase the power required for pumping sludge to the site.

3.) The site has somewhat more topographic relief than Site B-2 and thus will require more excavation for bed construction. This will increase construction costs.

4.) The City and County of Denver plans to eventually use its entire 1,050 ha [2,600 acres] in the Lowry Bombing Range as landfill. Denver has indicated an unwillingness to relinquish this land permanently for the proposed use (see Letter #9), because this would substantially decrease the life of the landfill. This could present a problem in acquiring land at Lowry; some other parcels not now used for sludge disposal operations would be required.

5.) The Lowry site is somewhat closer to housing development than is Site B-2. Development is occurring about 10 km [6 mi] west of the Lowry Site.

6.) The pipeline to Lowry will have to go through a more developed area than that to Site B-2. The route could, however, follow existing right-of-ways and thus minimize the pipeline construction impacts.

In terms of other factors such as distance to markets, aesthetics, distance from Metro plant, and land cost, the two sites are approximately equivalent. Lowry is somewhat closer to Denver metropolitan parks, but Site B-2 is closer to irrigated farms.

The Lowry Site clearly has a number of disadvantages with its use, several of which may be difficult or impossible to resolve. It appears from the above advantages and disadvantages that Site B-2 is still preferable to Lowry for the drying and distribution center. However, if for any reason Site B-2 cannot be acquired, the Lowry Site should be considered as the preferred alternative because of its lack of probable public controversy and present use for sludge disposal operations.

ISSUE IV-2. Why couldn't alternative technologies such as incineration, thermophilic digestion, "the Swedish method", or pyrolysis be used instead of the Metro offsite solids proposal?

This issue has been addressed in part in Volume I of the EIS under Section II entitled "Alternatives". This section describes the various technological alternatives considered by CH2M Hill, consultants for Metro, by EPA's consultant Engineering-Science, and by EPA itself. These discussions need not be repeated here. This section will discuss technological solutions to sludge disposal raised by individuals and agencies during the draft EIS review process.

Incineration - Pyrolysis of Wastewater Treatment Plant Sludges

Incineration of sewage sludge has been practiced in various forms since the early 1900's. Air pollution problems, rising energy costs and the advent of more advanced type sludges which are more difficult to dewater have led to more advanced equipment designs (Reference 40). Traditionally, combustion of sewage sludge has been viewed as a means of disposal, but recently more attention has been given to recovery of the energy in sludge. In order to efficiently combust sludge, it must be initially dewatered to a solids concentration of greater than about 25 percent. Sludges with a higher water content than this will require auxiliary fuel for proper combustion.

The heat value of wastewater sludges ranges from 11,200 to 23,000 Kj/Kg [4,800 to 10,000 BTU/lb] (Reference 41). Most sludges require auxiliary fuel to maintain combustion, which is the major operational cost (Reference 40). Two types of incinerators are commonly used, the multiple hearth furnace (MHF) and fluid bed furnace (FBF). The FBF has a lower capital cost and lower auxiliary fuel requirements than the MHF, but has more operating and maintenance problems.

Incineration was considered as an alternative in the original facilities plan and in the EIS, and was found to have high capital and energy costs and to have potentially severe air pollution problems. Incineration is the disposal method preferred by Metro if for any reason the proposed drying and reuse system cannot be implemented.

Pyrolysis is defined as the gasification and/or liquification of the combustion elements by heat, either in the total absence or in the presence of a controlled amount of oxygen (Reference 40). The useful product of pyrolysis of sludge is a fuel gas consisting of such gasses as carbon monoxide, methane, hydrogen, ethylene and some higher hydrocarbons, as well as appreciable quantities of carbon dioxide and water vapor. An ash is also produced which contains non-combustible material and some fixed carbon not volatilized during combustion. The yield and composition of pyrolysis products are dependent upon the complex interactions of several variables making prediction of the final products difficult.

Pyrolysis has recently been investigated as a more efficient alternative to incineration (Reference 40). Conventional MHF and FBF units can be converted to pyrolysis reactors with minor changes. Use of pyrolysis results in heat recoveries up to 82 percent greater than that attained by incineration. Pyrolysis gas has a heat value of up to 4.84 Kj/l [130 BTU/standard cubic foot].

Pyrolysis has not yet received widespread testing and field application, although it is being used successfully by some agencies. This alternative was also considered by the facilities plan and in the EIS, but was rejected because of its still unproven technology for a project as large as this one.

Thermophilic Digestion

Thermophilic sludge digestion is distinguished from mesophilic or standard digestion, in that digestion occurs at temperatures in the range of 49-57°C [120-135°F] instead of 30-38°C [85-100°F]. Advantages of operating in the higher temperature range are that pathogens are more effectively killed, digestion proceeds more rapidly, and increased quantities of methane gas are produced. Disadvantages are that the process is more sensitive to slight changes in temperature, digestion tanks may require insulation, more fuel is required for heating, and more careful operation is required.

Thermophilic digestion has not been widely used in the past, primarily because the disadvantages have usually outweighed the advantages. The most significant advantage of this mode of operation to the proposed project would be the more effective reduction of pathogens in the digested sludge. Metro already has anaerobic digesters which were designed for and are operating in the mesophilic range. These digesters may not be suitable for thermophilic operation. Metro is interested in reevaluating the design of the digesters to see if thermophilic digestion could be used. This option is, therefore, still open to Metro within the constraints of the present digestion system design.

Swedish Method

We think that the "Swedish Method" referred to by several people is the Clivus Mulstrum or other similar types of on-site waste disposal systems recently developed. These systems utilize composting toilets and washwater trickling filters with a drainfield for disposal rather than discharge of wastes from a home to a central sewer system. Solid and liquid wastes are composted in the system and the product is eventually utilized as a soil conditioner on-site.

While this system has been shown to be feasible in numerous lcoations, both in the U.S. and abroad, its use has been mostly confined to a few individuals willing to try an alternate waste disposal/utilization system. The system requires more user care and maintenance than the current waste disposal systems used in the Denver region and throughout most of the U.S. Its use on a widespread basis will require much research into the health, public awareness and acceptance, financial and technical aspects of its operation. One of the stated advantages of the system is that it is cheaper on a per capita basis to install than a sewer network with a central treatment plant. However, in an area such as Denver where the sewers and treatment plants have already been built, this advantage does not exist.

In summary, widespread use of this system will not be feasible in a large metropolitan area such as Denver for some time. A great deal of research and public education will first be required. The system does have many advantages, notably a greatly reduced water requirement and recycling of wastes, and research into its use should be pursued. This type of research is not, however, within the scope of an agency such as MDSDD#1 at the present time.

ISSUE IV-3. Should EPA participate in separate planning and funding for Denver Northside (DNS) Treatment Plant Sludge Disposal as suggested by Denver?

This was not at issue at the time of release of the draft EIS. The City and County of Denver indicated in their letter of comment on the EIS (see Letter #33), that they are interested in pursuing federal funding for separate sludge treatment and disposal at the Northside Plant.

The identified benefits described in the letter by the Denver Department of Public Works for a system of onsite sludge drying beds is as follows (Reference 42):

"1. The Denver cost of pumping digested sludge to Metro at a 5 percent solids concentration will be precluded;

2. The cost and use of chemicals (polymers) added to assist in Denver sludge dewatering by Metro will be eliminated;

3. The total cost of dewatering the Denver sludge at Metro (vacuum filtration) will be eliminated;

4. The cost of transporting the Denver sludge, plus residual chemicals, to a disposal site will be eliminated;

5. The life of the disposal site, insofar as sludge disposal *is concerned, will be increased by about 15 percent;*

6. Sludge recycling can be accomplished much sooner by utilization of the Denver drying beds;

7. There is an immediate market for dried sludge within the Denver Parks department;

8. There is a strong possiblity of handling additional digested sludge from the Metro District at sometime in the near future;

9. Possible advantages accruing to the Metro District in view of this proposal and the fact that Metro will, in the near future, have its own anaerobic digester capability, are
  a. a viable alternative by reducing the land requirement for the Metro sludge farm;
  b. cost savings of a potentially considerable magnitude concerning pipelines, pump stations, land acquisition, land development, litigation costs and replacement water costs; and

10. Preliminary savings in excess of $300,000 can be realized by the City and County of Denver in handling its own sludge disposal. Overall savings to the agencies involved in the Metro District could be considerably more. . ."

Background information of the Denver Northside Plant sludge operations is found under Issue I-6. It is important to note that all planning heretofore has included Denver Northside sludges in the Metro offsite solids reuse plan. This issue discussion also focuses on potential modifications to Northside's operation by including the digester supernatant in the pipeline flow that could reduce costs at the Northside plant as well as at Metro.

The assumptions stated above by the City and County of Denver must be qualified. Relevant points will be discussed in turn here.

Points #1 through #4. These are in fact identifiable costs factors of the present DNS-Metro sludge operation. Estimates of the change will be provided below.

Point #5. This is true; however, since there is considerable uncertainty as to exact capacities needed, and since the bulk of the costs will occur in the initial construction, this is probably not an important issue. Changes in mode of operation of drying could also have the same effect.

Point #6. This would be true if no objections would be raised to the drying bed proposal. EPA does not feel this is the case. This is discussed in more detail below.

Point #7. This is true; however, the Denver Parks department is now using Metro sludge, and would likely continue to do so under the offsite drying proposal. Therefore, the Northside proposal is simply another way of providing the Parks Department sludge. It should be tested on cost effective, engineering and environmental grounds. We also assume that the DNS system will have to haul to the bombing range any sludge the parks cannot use.

Point #8. This is also true. However, this fact would work against the DNS drying bed proposal. The Metro plant has an imbalance of secondary to primary sludge; Northside treats only primary sludge. If Metro were to send sludge to Northside for treatment, it would undoubtedly be secondary waste activated sludge (WAS). Current Metro experience is that any significant amount of WAS in anaerobic digestion greatly reduces the dewatering capability. Hence, Northside would find its drying beds working less well than with the easy-to-dewater primary digested sludge. Odor problems would be more likely. Digester decanting would be more difficult. The use of single-stage digestion with discharge of the contents into the pipeline system, however, would not hurt DNS operations even after mixing with secondary WAS.

Point #9. Based on the relatively small volume ratio of DNS to Metro sludge, and the advanced nature of the project, EPA seriously doubts there will be any significant cost reductions to the offsite project if the DNS sludges are treated separately. The land area requirement for the drying basins is relatively insensitive to drying capacity. The site would still be about 810 ha [2,000 acres] in order to provide research and buffer areas. Because Metro recognized an inflation problem, they plan to construct all of the drying beds initially. Pipe sizes and pumps are also highly insensitive to a small change in flow. No reduction would likely take place here either. A considerable change in design at this point would also cost money. EPA assumes for cost calculation that there would be no change in project size if DNS flows are removed. There are, of course, operational cost differences that will be calculated. Litigation costs will undoubtedly be the same with either option. There are no identifiable water replacement costs at present.

Point #10. The last point regarding cost savings of $300,000 per year, is surprising, to say the least. An article in the publication SLUDGE (Reference 43), raises the apparent cost savings even higher. This article has been reproduced here for convenience.

"AROUND THE STATES

Colorado -- Metropolitan Denver Sewage District Board last month tentatively approved a $1.25 million plan for the City of Denver to dispose of its own sewage sludge. Plan calls for reactivation of 64 abandoned sludge drying beds at the Denver Northside Treatment Plant and hauling treated sludge to the Metro disposal site on the old Lowry Bombing Range east of the city. Denver officials say the plan will reduce annual costs from $500,000 to less than $100,000; Metro officials say Denver's handling its own sludge processing will cut Metro's sludge processing costs $300,000 per year. Final approval of the Metro Board is required before Denver can apply for Federal funding."

Metro provided more detail on this reported cost savings in their recent correspondence (Reference 42).

The increased cost of processing Metro sludge separately is equal to:

$2.00 per dry ton	x	79.3 tons per day	=	$159 per day.

Metro's comment on EPA's inquiry into the SLUDGE article was as follows:

"It would appear that EPA officials have assumed that the savings which would accrue to Denver and Metro were additive, and they are not. It is rarely clear where the information for such articles comes from. Such articles often do not have any basis in fact. The resolution regarding this matter, passed by the Board of Directors at the November 1976 meeting is reproduced. . .

RESOLUTION
BOARD OF DIRECTORS
METROPOLITAN DENVER SEWAGE DISPOSAL DISTRICT NO.1
November 16, 1976

WHEREAS, the City and County of Denver has requested that the Metropolitan Denver Sewage Disposal District No. 1, hereinafter referred to as the "Metro District", approve the reactivation of the Denver Northside Treatment Plant sludge drying beds; and

WHEREAS, the staff of the Metro District and the Operations and Budget Committees have reviewed the proposal and recommend that the Board of Directors approve the request of the City and County of Denver; and

WHEREAS, the Executive Committee has reviewed the proposal and the recommendation of the staff and other Committees and adopts said recommendation and recommends that the Board of Directors approve such a request;

NOW, THEREFORE, BE IT RESOLVED, that pursuant to C.R.S. 1973, 32-4-548; the Bond Resolution, Section 820; and the Service Agreement, Section 304, the Board of Directors of the Metropolitan Denver Sewage Disposal District No. 1 hereby consents to and approves the plans and specifications for the reactivation of the sludge drying beds of the City and County of Denver at its Denver Northside Treatment Plant."

City and County officials have also offered a limited amount of information on the costs of separate sludge drying bed reactivation (Reference 11):

> *"1. There are currently 64 sludge drying beds on land which contain the Denver Northside Primary Treatment Plant. The beds were used until 1966, at which time they were filled and sludge was pumped to the Metro Plant. Renovation and modification of the beds include restoration to original condition, placing an impervious bottom in each bed, installation of a gravity underdrain system, placement of a graduated sand filter over the underdrains, and construction of a collection system to return bed effluent to the plant headworks.*
>
> *2. It is anticipated sufficient area exists to permit year round drying of all primary sludge produced at the Denver plant. In the event of an unusually wet year with subnormal evaporation, flexibility exists in having the capacity to transfer digested sludge (not dried) to the Metro Plant for disposal.*
>
> *3. Estimated costs for accomplishing the proposed plan are as follows:*

A. Study and Design	*$ 75,000*
B. Construction	*1 250,000*
C. Operation and Maintenance (annual)	*70,000"*

EPA initially assumed that the cost savings were additive. This is not the case; Metro District costs are absorbed by the City and County of Denver and other district members. Therefore, the cost saving of $254,000 to Metro would be shared in a 2:1 ratio between Denver and the other members. We still have a problem in trying to understand how Denver itself could save so much ($300,000/year).

EPA, therefore, developed a cost-effective alternatives analysis to better understand the situation. Four separate alternatives were analyzed to look at both the present Metro system and the offsite solids project, with and without the Denver Northside sludge flows. The four alternatives costed out are:

1) The present arrangement (as of 1976 costs) of DNS sludge being pumped to Metro for treatment. Treatment at Metro consists of vacuum filtration and hauling to Lowry for land spreading. Out of 4413 mt [4854 tons] of digested sludge pumped annually to Metro, 2730 mt [3000 tons] are separately vacuum filtered using polymers and hauled away by the Denver Parks Department. The remaining 1683 mt [1854 tons] of DNS sludge is vacuum filtered and hauled away to Lowry Bombing Range.

2) Metro continues to treat its own sludge by vacuum filtering and hauling to Lowry. Northside constructs sludge drying beds for $1.25 million. Disposal of DNS sludge is exactly the same as above (costs will vary on hauling).

3) Offsite solids project as proposed. Cost calculations assume that Parks Department will haul dried sludge from B-2 site directly to parks. System assumes that DNS digester decant is included in the pipeline flow.

4) Offsite solids project with DNS sludge drying project. Parks Department takes same amount of sludge as 1. It is assumed that offsite project size and cost is the same as 3.

The results of this analysis, as well as the key assumptions, are presented in Tables 11 and 12. The first table presents the results in terms of "Costs to Denver and Costs to other Municipalities". Table 12 identifies the present worth annual equivalent costs to all parties affected by Denver Northside/Metro sludge operations. It should be noted that the present worth analysis makes some simplifying assumptions: 1) no salvage value calculation, and 2) no O & M cost increases over time. The latter assumption was necessitated by the lack of long-term comparable cost data. However, it can probably be assumed that Denver and Metro O & M costs will rise proportionately with both the present and offsite solids systems.

The immediate conclusion in looking at these tables is that there are relatively small cost differences in the various systems. There appears to be little reason to justify separate Denver sludge disposal when all factors are taken into account. The principal reason for the lack of any really large differences is that the processing of Denver Northside primary digested sludge simply is not a very large cost item. This is to be expected since the total ratio of DNS to Metro sludge is small (about 15 percent of the total) and the digested primary sludge dewaters well.

Metro considerably overestimated their own cost savings if Northside sludge were removed ($255,000). If, in fact, the Denver Parks Department will take the polymer conditioned sludge as was suggested in this analysis, the cost savings to Metro of removing DNS sludge would be only about $178,000 per year. This would have to be balanced by Denver's increased costs of treatment at Northside. It is difficult to understand how Denver officials could have arrived at the $300,000 annual savings figure. The City of Denver's total sludge costs include Northside sludge treatment and disposal costs, Denver's 67 percent share of Metro's treatment costs, and Denver Parks Department sludge handling costs. Calculated with these considerations, Denver's short-term savings is about $10,000 per year. Other Metro district members would share a $162,000 per year savings.

Once the offsite solids project is built, the separate treatment by Northside would become much less cost-effective. In particular, the City and County of Denver would stand to lose on the order of $115,000/year as a result of paying for the bulk of two sludge treatment projects. EPA fails to understand the rationale behind the City's opting for separate sludge treatment. Based on the cost-effective analysis above, EPA cannot justify the need for separate facilities.

Separate sludge treatment at Denver Northside was evaluated by the consulting firm of Camp, Dresser and McKee in 1974 (Reference 11), including the potential for reactivation of the sludge drying beds. The consultants did not recommend proceeding independently, based on the following evaluation:

> *"In the following paragraphs, alternative methods for the disposal of anaerobically digested sludge from the Northside plant, if the present disposal method is discontinued, are briefly discussed. These alternatives were not studied in depth, because it is assumed that there will be no change in the current procedure.*
>
> *It is reported that digested sludge was formerly conveyed to the Denver Parks Department for use as a soil conditioner. This department's requirement for sludge has not been investigated, but it obviously would be far less than the quantity available from the Northside plant.*

Table 11. ANNUAL COST TO THE CITY OF DENVER AND OTHER METRO MEMBERS FOR VARIOUS SLUDGE TREATMENT ALTERNATIVES AT NORTHSIDE

Plants & Paying Municipalities	Unit Processes Costs		Alternatives (Annual Costs in Dollars)		
		1-Present Operation	2-Present Metro & Separate DNS	3-Metro Offsite	4-Metro Offsite & Separate DNS
1. Denver Northside Plant	O&M				
	Sludge Processing	$213,000(3)	$213,000	$213,000	$213,000
	Drying Beds	-0-	52,300 (8)	-0-	52,300
	Haul to Lowry	-0-	33,000 (9)	-0-	33,000
	Other	-0-	-0-	(-) 25,000(12)	-0-
	AMORT CAPITAL COSTS	-0-	30,000(10)(local)	-0-	30,000
	TOTALS	$213,000	328,300	188,000	328,300
2. Denver Parks Dept.	O&M	58,500 (4)	58,500	25,800(13)	58,500
3. Metro District Plant	a. O&M(DNS Sludge Only)				
	Pumping	17,100(5)	-0-	30,000(14)	
	Vacuum Filter	118,000(6)	-0-	-0-	
	Haul to Lowry	43,500(6)	-0-	-0-	
	b. O&M (All other) Total	2,677,400(7)	2,677,400(11)	563,000*(15)(16)(17)	508,000
	c. AMORT CAP COSTS	-0-	-0-	420,000(18)	420,000
	TOTALS	2,856,000(7)	2,677,400(11)	1,013,000	928,000
4. 67% of Total(1) Sludge Operations Paid by Denver		1,904,000	1,785,000	675,000	618,700
5. 33% of Total (2) Metro Sludge Operations Paid by Other Municipalities		952,000	892,000	338,000	309,000
Total Sludge Cost(1) Paid by Denver (1+2+4)		2,175,000	2,166,000	890,000	1,005,400

*Total Includes DNS Sludge Costs

FOOTNOTES FOR TABLE 11

(1) The City of Denver is obligated to pay for three different areas of Denver Northside-Metro plant sludge treatment: 1) the costs at the Northside plant, 2) the Denver Parks Department's sludge preparation for park use and 3) 2/3 of the Metro treated plant sludge costs.

(2) All other municipalities in the Metro District pay for the other third of the capital and operating costs, as we understand it.

(3) Metro data cited $15/ton to process Northside sludge. Annual figure based on the total value of sludge generated at the Northside plant (4854 tons 1/3)

(4) Metro data from Denver Parks Department: $16/ton to dry and haul and $3.50 to spread. Assumes 3000 dry tons/year to Parks Department and 1854 dry tons/year of Northside sludge to Lowry.

(5) Metro data: $3.60/ton

(6) Calculated data based on 1976 Metro performance and budget data: $24.50/dry tons to vacuum filter Northside sludge and $23.50 to haul to Lowry landfill; average Metro costs are higher.

(7) Based on 1976 actual Metro operating costs

(8) Estimated by Denver Northside at $11/ton

(9) Assumes 25% dryness at $4.45/wet ton to haul to Lowry (1854 tons/year)

(10) Estimated Denver local 25% annual repayment share (20 years, 7% interest)

(11) Simple difference between 3b and 3a under Alternative 1.

(12) Rough estimate of lowered Northside costs by switching to single-stage digestion and lack of implant recycle.

(13) Cost to Parks of truck hauling 3000 tons of dried sludge to Parks (no storage, drying, or preparation assumed).

(14) Estimate including added pumping costs of decant

(15) Worst-case assumption of disposal of 24,300 tons of dried sludge in Lowry landfill @$3/ton hauling costs (Metro estimate)

(16) Metro data.

(17) Includes a very conservative estimate of cost-savings to Metro as a result of a 270 reduction in BOD/SS from Denver Northside to Metro secondary facility. If advanced waste treatment is needed at Metro, the ammonia reduction would further reduce Metro operating and capital costs (perhaps 5-7%)

(18) Total project cost $17.6 million (Metro estimate) amortized at 7% interest, 20 year repayment.

Table 12. PRESENT WORTH ANALYSIS FOR VARIOUS NORTHSIDE-METRO SLUDGE ALTERNATIVES
(thousands of dollars)

		Alternative 1 Present Operation	Alternative 2 Present Metro Separate DNS	Alternative 3 Metro Offsite Solids Project	Alternative 4 Metro Offsite & Separate DNS
Northside Plant	Capital (total)	0	1,250	0	1,250
	O & M (Annual)	59	298	188	298
Parks		59	59	26	59
Metro Plant	Capital (total)	0	0	1,766	1,766
	O & M (Annual)	2,856	2,677	593	508
Total Present Worth		33,138	33,392	26,149	280,138
Annual Equivalent Cost		3,128	3.152	2,468	2,644

Assumptions:
1. No salvage value at end of repayment period.
2. No growth requiring further sludge treatment expansion or additional operating costs, and no inflation costs.
3. Data from Table 11 on Denver costs.
4. 20 years of operating costs.
5. 20 year repayment at 7% interest.
6. 1976 costs for O & M.

Because digestion may not destroy all pathogenic organisms, there is a potential hazard in applying liquid sludge to land. Other factors of concern are the effects of nitrogen compounds and of heavy metals. Land application of liquid sludge has been extensively studied and practiced throughout the world for many years. Under certain conditions and with certain controls, the method is satisfactory and beneficial agriculturally. However, additional studies of the specific area to which the sludge would be applied and the means of applying it would be necessary before this method could be recommended in Denver.

Other methods include:

Vacuum filters (followed by landfill or incineration)
Pressure filters (followed by landfill or incineration)
Drying beds (followed by landfill) . . .

DRYING BEDS. Drying beds depend largely on drainage and evaporation, although in some cases gravity separation and decanting of the clarified supernatant are used. Drying bed size depends on the nature and quantity of sludge, climate, and soil conditions. Comparatively large areas of land are required; this factor, and the serious odor problems associated with drying bed operations, would probably preclude its use at the Northside plant. Advantages of drying beds include reduced expenses and ease of operation. Disadvantages include area required, potential nuisance problems, susceptibility to adverse weather conditions, and the requirement that sludge be well digested prior to dewatering.

Liquid sludge is conveyed by a drainage system to the drying bed. After 1 to 3 months' dewatering, sludge is removed by mechanical scraper or hand shovel and the drying beds are restored by removal of the top few inches of sand and discing. The top layer of sand is then replaced. This operation is the major item of expense in sludge bed operation.

The least costly system for drying and disposal of anaerobically digested sludge is usually the drying bed-landfill combination. However, land availability and the effect of returned drainage liquid on plant operation must be evaluated, if the Northside plant sludge is to be disposed of as a separate operation. If these factors detract from the choice of this system, vacuum filtration and landfill would probably be the next most acceptable alternative. Systems employing incineration usually have a high initial cost, which precludes their use unless suitable conditions for landfill are not available.

No additional conclusions can be made at this time. Choice of drying beds, vacuum filters, or pressure filters for dewatering should be based on additional studies and tests, if the present sludge disposal system is discontinued. . ."

EPA is similarly concerned about a number of impacts mentioned by the consultant -- odors, large amounts of land required, nuisance conditions and adverse weather problems. There are residential areas in close proximity to the Denver Northside plant. The old drying bed areas now act as a buffer to these residential areas; utilizing the beds could put the sludge operation quite close to existing residences. If waste activated sludge were to be mixed with the Northside primary, the possibilities for odorous sludges would be increased. EPA feels that an EIS would probably be required if such a proposal were to be funded.

EPA sees no advantage in having Northside develop the drying beds for Parks Department use. As the consultants' analysis above indicated, the Parks Department would, in all probability, not be able to use all of Northside's sludge. The remainder would probably have to be hauled to the Lowry Bombing Range. Under the Northside system, the Parks Department would have to further dry and store the sludge before it could be used at park areas. Metro's offsite system will perform this in the drying/storage process. Thus the Parks Department could use this sludge directly.

A final factor to be considered is that given the assumption that the offsite solids project will be built, there will still be two alternative processes for handling Northside (or Metro) sludge. The vacuum filters will still be available for occasional use. Metro officials have indicated that they are considering the possibility of vacuum drying, on the Metro plant site, a limited amount of digested polymer-treated sludge for park use. Since the anaerobic sludge can be filter-dried to 20+ percent solids, there will be little free water to contaminate groundwater or surface waters. As long as Metro suitably prepares the area to contain any surface runoff, EPA believes the problems will be minimal. This would accomplish the goal of allowing Parks Department use of sludge without expenditure of extra federal funds.

The potential market for dried sludge on park lands could expand. Letters in Volume I of this EIS (Appendix F) indicate an interest in dried sludge use by other communities, including Northglenn, Aurora and Commerce City. Either the offsite solids system or the Metro onsite proposal could provide for this demand. Based on the cost analysis, either system would be reasonably cost-effective. If one assumes an operating cost of about $4.50/mt [$5/ton] to further dry the vacuum filtered sludge, the total Metro cost might be $27 to $32/mt [$30 to $35/ton]. If the sludge were dried offsite and trucked back to Denver, a cost of about $23 to $27/mt [$25 to $30/ton] would result. Actual experience will better define these costs.

Based on this analysis, EPA believes that the City and County of Denver would be ill-advised to develop independent Northside sludge treatment capabilities. EPA will therefore not participate in any funding of plans, designs or construction of additional sludge treatment in the form of drying beds, unless persuasive evidence contrary to the analysis presented here can be offered.

EPA does recognize the importance of assuring a high quality dependable source of dried sludge for Denver Parks use. EPA believes that such use could in the near term constitute the most important reuse potential for Metro offsite dried solids. EPA will set a grant condition that Metro will not distribute the dried sludge to users, with the exception of municipal park districts, until State Agricultural use regulations on sludge are finalized. EPA believes that municipal park use has been firmly established without noticeable problems in the past. EPA also will strongly urge Metro to encourage such municipal use by avoiding unnecessary charges for sludge used in this manner.

ISSUE IV-4. What alternatives are available to control groundwater quality at Site B-2?

There are several ways to provide protection to the groundwater beneath Site B-2. The most positive, and most expensive, method is to provide a completely impervious liner beneath all the drying beds. Metro has provided an estimate of the costs and efficiencies of seven types of liners, shown in Table 13. As the table shows, a completely impervious liner such as Portland Cement Concrete or a PVC liner would be quite expensive. Bentonite clay is the cheapest of these liners; if installed as discussed in Issue II-2 with a cover layer of soil, a clay liner should not dry out and crack. Because of the large amount of clay at the site, Metro should be able to construct a liner without purchasing clay from an outside source.

In addition to lining the beds, there are two other methods by which groundwater pollution can be minimized or eliminated. The first is to install a series of alluvial wells around the perimeter of the drying beds, and pump out the leachate which reaches the alluvium. While this method would effectively remove most of the leachate which reaches the alluvium, if leachate moves into the bedrock aquifers directly beneath the drying beds it won't be removed. From the geotechnical investigation, it does not appear that the bedrock-alluvium interface will allow leachate movement into the

Table 13. DRYING BASIN LINER ANALYSIS SUMMARY

Material	Estimated Linear Cost	Comments
Bentonite	$ 4,600,000	Reduces seepage; doesn't stop it
		Will crack due to wetting - drying cycles
		Not appropriate for intended application
Soil Cement	$12,800,000	Will get shrinkage cracks
Portland Cement Concrete	$45,700,000	Hard impermeability
		Hard and durable
Bituminous Concrete	$20,100,000	Favorable past experience
		Dense and permeable
Bituminous Base Stabilization	$12,400,000	Not common for waterproofing hydraulic structures
		Efficacy uncertain
Asphalt Membrane	$10,100,000	Has many precedents
		1.5 gals/sq. yd. for 3/16" to 5/16" membrane
		Requires 1' to 3' earth cover
		Asphalt Institute says this is less costly and as good as any other liner
PVC Liner	$16,500,000	No seepage
		Requires minimum 2' soil cover

Source: MDSDD #1

bedrock directly below the beds (Reference 13). This method requires disposal of the water pumped up; it should be returned to the beds for removal by evaporation. No cost estimate is available for this option.

The second alternative to impervious liners is to install tile drains beneath the beds to collect the leachate. This system is commonly used with sand drying beds for leachate collection, and in other applications where removal of groundwater is required. This system would cost approximately $10,000,000 to install at Site B-2. The leachate would be returned to the beds for drying as with the well system. Most, but not all, of the leachate would be collected with this system.

Any of these alternative systems could be installed after the beds have become operative if monitoring of the groundwater determines that significant groundwater pollution is occurring or is likely to occur. The cost would probably be somewhat higher if liners are installed after bed construction, however. If clay liners with the permeability given in Issue II-2 are installed, the quantity of leachate is expected to be small enough that no further mitigation is necessary. At this time, it would be unwise to invest in a more costly alternative which may not be necessary, since at worst the monitoring program will determine if a problem develops and appropriate action could be taken at that time.

ISSUE V

SLUDGE USE

ISSUE V-1. Will EPA place constraints on sludge use because of public health problems from pathogens, salt accumulations, or effects of toxic substances (especially heavy metals and organics)?

The three principal constituents of sludge posing the possibility for constraints on its use for land recycling have been identified as toxic substances (notably heavy metals and certain complex organics), soluable salts, and bacterial and viral pathogens. Each of these will be discussed below, including consideration of areas in which constraints on use are felt appropriate.

Pathogen Survival and Transport

The Colorado State Department of Health has issued draft Guidelines for Sludge Utilization on Land (Appendix B). These guidelines set requirements for treatment, handling, use and regulation of sewage sludge utilized on land. The Department will be responsible for all monitoring and for enforcement of the compliance of sludge users with the guidelines. The proposed project will meet the requirements set forth in the draft guidelines for the treatment of sludge. The sludge will be disbursed to farmers and homeowners with instructions on its safe use; it will then be the responsibility of the user to follow the instructions, and the responsibility of the Department of Health to see that they are followed (Reference 5, Appendix B). The guidelines have been written with consideration of the most up-to-date knowledge of the potential problems which sludge application may cause. They have been designed to minimize the known harmful effects of sludge misuse. If the guidelines are rigorously followed and enforced, the possible negative impacts of sludge use will be substantially reduced.

A great deal of concern has been expressed over possible health problems caused by parasites, bacteria, and viruses in dried and stockpiled sludge. In view of the treatment the sludge will receive before distribution, i.e., anaerobic digestion, air-drying, and stockpiling for at least one year, this problem will largely be mitigated. The notable possible exceptions are *Ascaris* ova, which have been shown to survive for several years in sludges and soils. However, these survival times have been in moist, warm climates, which differ drastically from the cool, dry conditions in the Denver region. It is possible that these ova will be present in the final product; however, the extent to which this would pose a health hazard is unknown at present. Since digested, air-dried sludge has been fairly extensively used in the past with no documented health problems, it is felt that the risk posed by Ascaris would likely be quite small. However, medical checkups should be made available to anyone who uses the product, and if any signs of health problems due to sludge use are found, additional precautions (such as longer drying times) will be required. Also, sludge use by individuals on home gardens may be prohibited in order to lessen the chances of misuse and greatly reduce the number of people who come into contact with the sludge.

Pathogens may also be transported from the site by both insect vectors and by windblowing of stockpiled sludge. Insect control is discussed in Issue II-10. Although some insects will of course be found in and near the site, their numbers are expected to be small. The likelihood of human infection by this means is remote. Windblowing of sludge is discussed in Issue II-5. As noted in that discussion, only a minute quantity is expected to be blown from the stockpile area. The chances of human infection occurring from this means of pathogen transport is almost zero.

On a national level, EPA has been working on the development of criteria for uses of solid wastes, including sludges, as well as what constitutes "hazardous wastes" (which come under the control of the recently passed Resource Conservation and Recovery Act, PL 94-580). As of this time, the preliminary draft of regulations to implement these criteria indicate that wastewater treatment plant sludges containing pathogenic organisms are considered "infectious" (i.e., capable of producing human diseases) unless the sludge has received the treatment equivalent of anaerobic digestion (at least 10 days' digestion at 95°F and a 97 percent plus pathogen destruction). Under these criteria, the Metro land recycling proposal would meet the minimum criteria and would not be considered an infectious waste. The air drying and storage under this plan for a year's time or so would have a further pathogen-killing effect.

For this project's proposed uses, it is felt that the likely pathogen reduction achievable would make the sludge suitable for most agricultural uses. Only direct ingestion either by humans or domestic animals is felt to be still a potentially infectious situation that may need to be controlled (see discussion under Issue V-2 on Types of Uses).

Salt Contamination of Soils, Surface Water and Groundwater

The application of sludge containing salts could pose a significant impact on soils and groundwater where sludge is used. The chemical constituents of a ten-day composite sample of anaerobically digested liquid sludge from the Denver Northside Plant is given in

Table 14. The sludge eventually sent to the drying and distribution site is expected to have concentrations similar to those in this table. These data indicate soluable salt concentration (~2000 ppm TDS) considerably less than estimated in the draft EIS (up to 6000 ppm TDS).

Volume I of the EIS discusses problems related to salt accumulation in the soils in Section V, Section VII, and Appendix D. As these discussions indicate, increased salt concentrations in the soil resulting from sludge applications over a long period of time could decrease plant yields. Consequently, soils receiving sludge on a regular basis should be monitored for accumulation of salt. This is easily accomplished by measuring the electrical conductivity of a soil extract solution. If the conductivity begins to approach about 4 mmhos/cm, sludge use should be discontinued. This problem is not expected to be severe for either dryland or irrigated farms. For dryland farms, the sludge application rate is so low that salt will probably not accumulate to a harmful level to plants for an extremely long time (on the order of 100 years). For irrigated farms, the leaching provided by irrigation waters should prevent a harmful buildup of salts.

It should be recognized that 32 percent of the total weight of soluble salts reported in the Metro data are considered plant nutrients (NH_4^+, $PO_4^=$, and K), and are commercially applied as fertilizer on cropland. Based on this evidence, it does not appear that salt accumulations would pose a hazard for sludge users. Therefore, apart from monitoring dryland areas occasionally for conductivity and applying good irrigation practices to move salts through the soil profile, no further mitigation is felt necessary at this time.

Heavy-Metal Accumulation in Soils and Crops

One of the prime concerns about extensive use of sludge on farmland is the potential damage to crops and soils by heavy metals in sludge, as well as the risk posed to humans by accumulations in the human food chain. The metal content of Denver sludge and proposed programs for reduction of metals in the system are presented in Issue I-1.

A large amount of research is currently being conducted on the effect of the trace metals in sludge on crops and soils. The effects of metals vary widely depending upon soil and crop type to which sludge is applied. Leafy plants combined with low-pH soils are the worst conditions with regard to the occurrence of toxic metal levels. Volume I of this EIS discusses the heavy metal problem as it relates to the proposed uses in Section V and Appendix D. The conclusion is that the proposed farmland sites for sludge application

Table 14. CHEMICAL CONSTITUENTS OF ANAEROBICALLY DIGESTED PRIMARY SLUDGE FROM THE DENVER NORTHSIDE PLANT

Analysis	Concentration In Liquid Sludge	Concentration mg/kg Dry Solids
Total Solids	6.9%	-
TDS	2110 mg/l	-
HCO_3	360 mg/l	5200
NO_3	0.4 mg/l	5.8
PO_4	32 mg/l	463
NH_4	576 mg/l	8350
SO_4	10 mg/l	145
Cl	375 mg/l	5400
K	66 mg/l	960
Na	114 mg/l	1650
Ca	93 mg/l	1350
Mg	20 mg/l	290
Conductivity	4180 umhos/cm	-

are well suited for minimizing the impacts from sludge metals. The reasons are the highly calcareous soils in the area, the relatively low sludge loading rates proposed, and the relatively high phosphorus content of Denver sludge which tends to make both zinc and cadmium less available to plants.

A study of the application of liquid sludge to wheat in Adams County was carried out in 1974 to determine the metal composition of the wheat and soil after application (Reference 3). This study analyzed a number of metals and used sludge loadings of 0, 55, 109 and 150 mt/ha [0, 20, 40, and 55 tons/acre] on test plots growing hard winter wheat. Of all the metals tested, only zinc, cadmium and nickel showed significant increases in the sludge-amended wheat as compared to the control wheat. The value for zinc, though higher, was still within the range expected on the basis of an analysis of 12 wheats from various other parts of the county. Nickel and cadmium would then appear to be the two metals of concern for Denver sludge. It should be noted, however, that an analysis of Denver sludge from 1972 to 1973 showed a very high nickel concentration of 562 ppm (Reference 6). A more recent analysis, in 1975, gave lower values for nickel as shown in Table 1. The application of sludge to wheat reported in this section was carried out in 1974. It appears that the nickel content of Denver sludge may be decreasing; a source control program should decrease it even further. Also, the report stated that even though the levels of these two metals are anomalously high, they do not appear to be potentially detrimental to either plants or animals, including man.

In the sludge-amended soils, cadmium was below the detection limit of 1 ppm, nickel showed a slight increase, and zinc approximately doubled in soils with the highest loading, increasing less with the intermediate loadings. Copper, lead, mercury, silver and tin also showed marked increases in sludge-amended soils, with antimony, arsenic and chromium showing lesser increases. The soil pH was also decreased somewhat by the sludge addition.

When comparing these results with what may be expected to occur with the proposed drying and recycling plan, it must be remembered that the cited study used liquid sludge, whereas primarily dried sludge will be applied in the project under consideration. The application rates (dry weight basis) were in the upper range of the probable rate of dry sludge to be applied to irrigated farms and sod farms, and are considerably higher than the rate that would be considered for dryland farms. Also, when sludge applications are based initially on supplying the crop with adequate nitrogen. applications of potentially toxic metals will be limited to levels that are of no concern except for sludges that have an excessively high metal content (Reference 38). Nickel is the anomolously high metal in Denver sludge; proper source control should ameliorate this condition. Another factor which will lessen the impact of metals on soils in the area is the high pH of the soils; all are well above pH 6.5, which is the recommended minimum (Reference 2). Taking into account these considerations, no harmful short-term effect on crops is likely to occur from trace metals.

Along with pH, the soil cation exchange capacity (CEC) plays a large part in controlling the effects that heavy metals in soil will have on plants. The higher the CEC, the greater the concentrations of metals which can be tolerated in the soil without ill effects. Table 15 gives the total amount of various metals which should be added to soils having low, medium and high CEC's. Application of sludge to a parcel of land should be terminated when any metal listed in the table exceeds the recommended limit. The quantities of each metal added can be calculated knowing the concentration of the metal in the sludge and the sludge application rate.

A study of the soils at Site B-2 in 1976 determined the CEC of two typical soils which are expected to represent the range of soil properties at the site (Reference 7). The Ulm series soil profile had an average CEC of about 30 meq/100 gm, and the Ascalon Series profile averaged about 15 meq/100 gm. Both of these CEC's are in the high range given in Table 15. If these CEC's are representative of those found in the entire area, then the soils should be well suited to minimize problems resulting from metal applications.

The only metal not listed in Table 15 which is considered by the CAST study to pose a potentially serious threat to cropland is Molybdenum (Mo)(Reference 38). Mo, unlike most other metals, increases in availability as the soil pH increases. Therefore, its application rate should be monitored carefully in the high-pH soils in the area. No recommended limits for Mo in soils have been determined. However, Mo does not appear to be very toxic to plants (Reference 38). If the total quantities of other metals are kept within the recommended limits, it is likely that no problems with excess Mo would occur. Metro should, however, include Mo as one of the metals routinely analyzed in its sludge.

Since continued application of sludge will cause a buildup of trace metals in the soil over a period of time, monitoring of metals in sludge-amended soils should be carried out every five years. If any metal approaches the limits in Table 15, sludge use should be discontinued. Monitoring at five year intervals should detect any potentially harmful metal accumulations before they reach the point at which crop damage or high concentrations in crops occur (Reference 38). The sludge will be monitored periodically for its metal content before it is disbursed to the users, and any dangerously high

Table 15. MAXIMUM RECOMMENDED QUANTITIES OF METALS WHICH SHOULD BE ADDED TO AGRICULTURAL SOILS

	Soil Cation Exchange Capacity (Meg/100g)					
	0 - 5		5 - 15		>15	
	Amount of Metal					
Metal	kg/ha	lb/ac	Kg/ha	lb/ac	Kg/ha	lb/ac
Pb	564	500	1130	1000	2250	2000
An	282	250	564	500	1130	1000
Cu	141	125	282	250	564	500
Ni	56	50	113	100	225	200
Cd	6	5	11	10	23	20

Source: Reference 44

concentrations detected before it is released to the user. EPA will recommend the above approaches to the Metro District, both for their own research as well as information to users.

The problem of metal accumulations in animals fed with hay or other fodder grown on sludge-amended soils may necessitate the exclusion of the livers and kidneys of these animals from public consumption. A sampling program to determine whether dangerous levels of metals are being accumulated in these organs should be instituted; in this way, the magnitude of the problem can be assessed. No dangerous buildup of metals should occur in other animal tissues. Metro is currently studying buildup of heavy metals in tissues of cattle feeding on areas of the Lowry Bombing Range containing Metro sludge.

The 1977 Amendments to the Clean Water Act require EPA to develop regulations or guidelines for sludge use and disposal. Congress recognized the right of local determination of the type of sludge use, but insisted that the systems chosen must be in accordance with the guidelines. EPA will have to identify concentrations of pollutants in sludge interfering with possible uses of sludge.

The following is the language of the Amendments pertaining to sludge use guidelines EPA would have to develop:

> *"(d) The Administrator, after consultation with appropriate Federal and State agencies and other interested persons, shall develop and publish, within one year after the date of enactment*

of this subsection and from time to time thereafter, regulations providing guidelines for the disposal of sludge and the utilization of sludge for various purposes. Such regulations shall -

> *'(1) identify uses for sludge including disposal;*
>
> *'(2) specify factors to be taken into account in determining the measures and practices applicable to each such use or disposal (including publication of information on costs);*
>
> *'(3) identify concentrations of pollutants which interfere with each such use or disposal.'*

The Administrator is authorized to revise any regulation issued under this subsection.

(e) The determination of the manner of disposal or use of sludge is a local determination except that it shall be unlawful for the owner or operator of any publicly owned treatment works to dispose of sludge from such works for any use for which guidelines have been established pursuant to subsection (d) of this section, except in accordance with such guidelines."

EPA will therefore be more directly involved in the future in defining where various constituents could pose limitations to sludge application. Limitations on cadmium suggested in grant condition No. 11 represent the pollutants EPA thinks pose the greatest hazard in sludge at this point in time. EPA recommends that no more than 1-2 kg/ha [1-2 lbs/acre] of cadmium be applied to cropland annually.

ISSUE V-2. Should constraints to Metro sludge use be set depending upon the kinds of use contemplated?

Metro has identified six principal markets for the dried sludge: (1) city parks, (2) sod farms, (3) mine spoil sites, (4) irrigated farms, (5) dryland farms, and (6) home gardens. In addition, a coal gasification project near Watkins may use Denver sludge as part of its fuel feedstock. Each of these uses with their impacts and possible mitigative measures have been described in Section IV and V and Appendices D and E of Volume I. The major aspects of each of these uses is briefly summarized here.

City Parks

The Denver Parks Department has been using dried sludge to aid in preparing topsoil for establishment of new parks. Since public use of park areas is high, particular care must be exercised to ensure that pathogens (especially Ascaris ova) are completely killed in the sludge product. The one-year stockpile time planned for

Denver sludge should achieve this goal. The sludge loading rate should also be limited to that which does not cause significant groundwater or surface water pollution from nitrates or TDS. This rate would ideally be computed by balancing the nitrogen content of the sludge with the nitrogen requirement of the grass being grown at the park.

Communities in the area other than Denver have also expressed interest in a similar use of dried sludge. In light of the succesful use of sludge for this purpose in the past, there seems little reason why it cannot continue. Other than maintaining careful management practices described above, there seems little justification for any further controls.

Sod Farms

Application of sludge to sod farms will probably be conducted by using manure spreaders or similar equipment. This application has the smallest potential for harm of any of the proposed uses. Sod farms have a high rate of irrigation which will help keep sludge particles and nutrients in the soil profile. The cyclic removal of thin layers of soils during harvest will prevent the buildup of any harmful sludge constituents which may be present. Sludge nutrients will help increase productivity while reducing the need for commercial fertilizers. Grass is a good crop for sludge fertilization because it is tolerant of heavy metals, is not used for human or animal food, has a high rate of nitrogen uptake, and minimizes problems from runoff and erosion. Only control of runoff during early stages of application is felt necessary as a mitigating measure.

Mine Spoil Sites

Many mining sites in the Rocky Mountains and elsewhere have large piles of acidic mine tailings created during the metal extraction process. Because of their coarse particle size and high acidity these inert heaps may remain unvegetated and unsightly for decades unless a deliberate effort is made to restore them. Sludge for this purpose will be mixed with wood chips and applied at a rate of about 67 mt/ha [30 tons/acre]. A higher application rate than this may prove to be optimal for reclamation.

These spoil sites are generally characterized by extremely acid soil conditions, high rates of erosion and runoff, toxic levels of certain metals in the soil, low soil fertility, low soil moisture content, and high summer surface temperatures. Sludge helps ameliorate these conditions by raising the soil pH, thus immobilizing to some extent the acid-leached metals, and helps build up desirable soil characteristics allowing plants to grow. Once vegetation has been reestablished, erosion and temperature problems are lessened. Because of the severe conditions at these locations, no crops for human consumption are grown there.

Mine spoil sites in the area are mostly located at high elevations in areas where little groundwater occurs. At the representative mine near Berthoud Pass owned by Climax Molybdenum, surface runoff flows into Woods Creek, which is a tributary of Clear Creek. Flow through fractures in the bedrock and into the streams is probably fairly rapid. The quality of this runoff before sludge application is quite poor and is highly acidic. The use of sludge on mine spoils may actually improve the surface runoff quality immediately by raising its pH. The runoff quality is still expected to be poor, however. The long-term effect on runoff quality and quantity will be beneficial, because of the improvement of the moisture-holding capacity of the soil and the revegetation of the site. In short, the conditions at these sites are already very degraded, the addition of sludge is unlikely to significantly degrade them further, and will in all probability improve runoff characteristics, at least in the long term. Such applications would best be characterized as experimental at this point in time. Exact management practices will be developed after more studying and monitoring is done.

Irrigated Farms

The use of sludge on irrigated farms is probably the most sensitive area of application. Care must be taken to ensure that the proper application rates are used. The method for computing application rates based on the sludge nitrogen content is given in Section IV of Volume I. These rates should be strictly adhered to, and the quantities of Zn and Cd added to each farm should be recorded. Since this application rate is site-specific for each farm and each soil type, it is important that the sludge limit be computed for each. If this is done, sludge should prove to be beneficial fertilizer for irrigated farms.

Control of irrigation rates and other standard farming practices will minimize the effect of sludge on groundwater and surface water quality. The impact of sludge nitrates on water quality should be no greater than that of commercial fertilizers, except that runoff from sludge-amended fields may have somewhat higher TDS than from fields not so treated. For this reason, sludge should be preferentially used on farms which are carefully managed and operated to minimize tailwaters. Generally, because of the intensive nature of this type of farming, irrigated farms in Adams County are operated with a high degree of control.

EPA does recommend that Metro sludge not be applied to land growing directly consumable vegetable crops in raw form, particularly leafy vegetables. Even such crops might be able to be grown on sludge amended fields, if the sludge were applied a year in advance of the growing season. Some risk of pathogen contamination would still be present, though small. No clear danger has been identified for growing crops such as corn, alfalfa, sugar beets, etc. with dried sludge. It would be advisable for Metro to continue experimentation on locally grown crops to identify the extent of heavy metals accumulation and toxicities in various crop species (and where in the plants these metals are concentrated, i.e. seeds, leafy parts, roots, etc.). Such a program could be developed in the context of the proposed project on Site B-2, and would be a helpful companion study to many already in progress nationwide by universities, EPA, USDA, etc.

Dryland Farms

Dryland farming constitutes the largest farmland area in Adams County. These farms are less intensely farmed and have considerably lower yields per hectare than do irrigated farms. Consequently, they require a much lower quantity of fertilizer. In practice, it is expected that injection of liquid sludge in bands beneath the soil surface will be more practical than surface application of dried sludge. This is primarily because the injection process will also scar the land, a common practice in the area, which allows better penetration of rainfall and improved water retention.

Dried sludge could also be applied at rates sufficient to provide for the crops' nitrogen requirement, as with irrigated farms. Because of the low application rates, buildup of heavy metals will be much slower than with irrigated farms. However, salt accumulation could be more of a problem with dryland farms because they will not be leached out of the soil. Salt content of the soil should be monitored on dryland farms receiving sludge in order to ensure that it does not rise to intolerable levels. If this is done, use of sludge on dryland farms should pose no other particular difficulties.

Home Gardens

This use of sludge entails some risks because of a high number of people being exposed to sludge and the impossibility of any agency monitoring each and every user. If sludge is dispensed to individuals, it should have been stockpiled for as long as practical, but at least one year, in order to ensure complete pathogen die-off. In addition, users should be clearly cautioned against using sludge on soils growing any edible crops, especially during the season of sludge application. Its use should be restricted to soils growing lawns or ornamentals. EPA is expected to issue an information bulletin in the near future on the home uses of sewage sludge (Reference 47). This bulletin will be prepared for both municipalities and the general public. EPA at this time has no well defined position on home uses, because of the wide divergence of opinion on the dangers involved.

If the sludge is bagged and clearly labelled as to recommended uses and potential hazards, then use on home lawns and gardens will be acceptable. Many small wastewater agencies in the U.S. presently allow the general public to use air-dried sludge with no restrictions. To date, no problems with this practice have been documented. Generally speaking, a user who goes to the trouble to acquire a product such as this will also take the trouble to use it properly.

EPA feels that the highest priority of control should be toward minimizing the entrance of quantities of heavy metals and toxic substances into the human food chain. Since leafy vegetables absorb fairly large quantities of heavy metals, sludge use should be restricted if it is used in home gardens near those crops whose leafy parts are consumed directly or where heavy metals are known to concentrate in vegetables.

Watkins Gasification Project

The Watkins project is a conceptual plan to develop largely untapped reserves of lignite coal near Denver. The coal will be combined with solid waste and gasified to pipeline quality natural gas. Denver sludge and solid wastes may be mixed together and pressed into briquettes. These would provide approximately 20 percent of the fuel feedstock for the project. This use of sludge is quite acceptable and should have no adverse environmental effects if normal precautions are taken to minimize air pollution.

In summary, EPA Region VIII will be making a number of definitive recommendations on restricting sludge use, and will recommend precautionary measures. A national EPA and other Federal agency task force is working to define the necessary restrictions on sludge use; regulations required under the 1977 Amendments will define the proposed uses and any constraints necessary. A consensus so far on appropriate limits has been difficult to achieve because of the variety of opinions and conflicting scientific research findings. At such time as regulations or technical guidance are available, Region VIII EPA will see to it that the Metro District implements new policies and practices regarding sludge use. It is EPA's belief that the basic design of the system provides adequate sludge treatment for most of the proposed uses. Caution is of course important where sludge will be used on human food chain crops. The need for good management practices with sludge use and continuing research are the two most essential other requirements for a safe sludge use program. It appears that the Metro District is committed to both of these.

ISSUE V-3. Are Metro's plans for use reasonable and compatible with the market trends?

Metro has identified a variety of potential uses for the dried sludge product (dryland farms, sod farms, etc.). Others have suggested the use of sludge as a fuel in a gasification facility near Watkins. A number of individuals (see petition under Appendix F, Volume I, signed by 461 persons, Letters # 1 and # 4 in comments on the draft EIS) and municipalities (see also Appendix F, Volume I) have indicated an interest in using Metro sludge.

More recently Metro District staff has indicated two other areas of potential sludge marketing: in the irrigated agricultural areas called Prospect Valley to the northeast of site B-2, and in preliminary negotiations with fertilizer manufacturers to develop a fortified, bagged sludge product. Metro now estimates it has a firm commitment to use 35 percent of the available sludge product.

If anything, Metro's proposals suffer from an overabundance of potential markets; making a definitive analysis of the firmness of these markets is correspondingly more difficult. What has not been done formally is a marketing study to test the feasibility and certainty of these proposed users, and the strength of the potential market demands. Two cities, Washington, D.C., and San Francisco, have conducted studies of potential sludge marketing areas, with occasionally conflicting and somewhat inconclusive results (References 48 and 49). Both studies indicate, however, that the potential markets are large enough to absorb all of the producible sludge from those cities. In the San Francisco case, the use of sludge in bagged form for home and specialty use (nurseries, etc.) appears to have the greatest potential market. In the Washington study done for the 208 Agency, estimates of potential markets varied by orders of magnitude, indicating the extreme uncertainty involved in predicting public response, although the potential market amounts could absorb the available sludge.

The latter point underscores the limitations of most marketing studies. The dried sludge product is something that can be made more or less attractive depending on public acceptance, how it is sold, and in what form. It is essentially the imagination of the seller that can determine how successfully sludge is eventually sold. An interesting sidelight on this is the number of communities now distributing dried sludge in some form that have adopted a trade name for their product: Nu-Earth (Chicago), Hou-Actinite (Houston), and BI Organic (Boise, Idaho) are but a few listed in Table 9 under Issue II-8. Apparently if the producer is convinced that the dried sludge product is a salable commodity, the public thinks so too. It is also instructive to see in this table how much more 50-100 lb. of sludge in bagged form can be sold for than sludge sold in bulk form.

The principal factor in the marketing situation is public aversion/acceptance of sludge as a useful product. EPA feels that a reasonable minimum in the way of technical design has been developed for this project by Metro; its overall success will be determined by how well Metro persuades the Denver metropolitan public that the product is worth buying. EPA itself has been promoting recycling of nutrients in sludge and wastewater and will continue to do so in the future. EPA feels reasonably confident that Metro is capable of promoting the distribution and sale of the dried sludge product to make the overall project a "successful" one.

ISSUE V-4. How will controls over sludge use and management be implemented, by Metro, the County, the State, or others?

This is an issue of obvious concern to local residents as well as County governments. Metro's own philosophy of its role in the management and control of sludge distribution and use is as follows:

> *Metro Denver will strictly adhere to the State guidelines regulating the use of sewage sludge. These guidelines are presently being drafted and should be in their final form within the next couple of months (see Appendix B). Until the implementation of this document Metro plans to abide by guidelines recommended by the U.S.D.A. and EPA.*
>
> *Metro will provide agricultural recommendations as to the proper use of sludge. Sewage sludge will be applied to agricultural land at agronomic rates which will be based upon soil analyses in conjunction with the type of crop grown. Records of use, i.e. amount applied by individual farmers to specific fields, and where possible, yield results will be kept by Metro. The chemical composition of sludge distributed will be determined; therefore, rates of N, P, K, and heavy metals application will be known. Since Metro is developing a long-term market it is to Metro's advantage to ensure that the sludge materials (Metrogro) are utilized properly to avoid any adverse consequences from the misuse of this product.*
>
> *If Metrogro is bagged, a complete chemical analysis, which*

will include macro-nutrients, Zn, Cu, Ni, Cd, and Fe will be placed on the bag. Complete control of bagged materials is impossible since the number of potential users is so great. Studies being conducted by EPA, Metro and U.S.D.A. will eventually determine possible pathogen hazards. Any bagged material sold to the public will be pathogen safe and recommended for lawn use.

"Guidelines for Sludge Utilization on Land", a technical policy document from the Colorado State Department of Health was released on December 8, 1976 in draft form. A copy of these guidelines are included in this volume as Appendix B. The guidelines provide a basis for evaluating the Metro sludge product and proposal; Section IV of the document on sludge quality defines minimum/maximum constituents of nutrients and heavy metals that qualify as applicable to agricultural lands. Metro's sludge appears to be consistent with this section.

Section V describes the manner in which agronomic loading rates can be estimated for various kinds of sludge applications. Other considerations for sludge application on land are given in Section VI that affect potential Metro uses: for instance, sludge shall not be applied to crops that could be eaten raw. A one year storage time shall be rquired for sludge to be applied to such crops. Livestock should not be allowed to graze on sludge application areas. Other considerations such as site slopes, ice conditions, and depth to the water table are also presented.

Section VIII defines the monitoring and analysis responsibilities of the sludge producer. An amended NPDES permit or a special disposal permit will be written for each producer of sludge. The permit will set the required monitoring including frequency of sampling and the required kinds of analyses. A producer will have to keep records of sludge distribution to be filed with the Health Department. A blank copy of such a permit is provided in the Appendix to this document. User permits would be required only where minimum standards set forth in this regulation are not followed.

Given the impetus of State control and Metro commitment, EPA believes that effective and safe management and guidance over sludge application can be attained with the Metro offsite project. EPA will periodically provide national guidance on technical and research findings concerning sludge use that could be incorporated into future State sludge use regulations.

ISSUE V-5 What are the long-term implications for sludge recycling to the land?

EPA has adopted a national policy strongly encouraging recycling of sludge, wastewater, and solid waste materials. In the long-run, there is no question that this nation will have to depend more on renewable resources and less on depletable resources such as coal, oil, rock phosphate, etc.

As this EIS has pointed out, reuse of human wastes is a very old process in agriculture. Two considerations--public health factors and the addition of technological waste products to municipal wastewater--have complicated and forced a thorough re-analysis of this essentially ancient recycling process. It is probably true that lack of hygenic practices may have at times contributed to the dissemination of water-borne human diseases in this process. With the rapidly developing understanding of the nature and spread of viral and bacterial pathogens, there appears to be no insurmountable obstacle to carefully utilizing stabilized municipal sludge in agricultural areas. There does remain some uncertainty regarding the exact fates of some pathogens, particularly viruses, but there is little in the way of substantial evidence to suggest that these viruses are a problem. Recent studies on the worldwide distribution and inter-species interactions of some viruses suggest that mankind is probably very limited in its ability to affect or drastically change the various viral transmission routes that have been established for eons. Prevention of obvious unhygenic and unsafe practices would appear to be the most prudent approach unless some definite evidence to the contrary is developed.

The introduction of largely chemical wastes (by-products of our industrial society) into municipal wastes does represent a novel situation that should be approached with caution. In particular there are heavy metals such as cadmium, chromium, etc. that do not occur in very large concentrations naturally, and the complex toxic organics such as PCB's and pesticides that appear to constitute the greatest potential threat to safe agricultural recycling of municipal sludges. At the same time, there is still little or no direct evidence that these materials in sludge have caused or will cause severe problems. It is generally by analogy to or extrapolation from other areas of study (e.g., exposures to industrial workers, animal toxicology studies, certain epidemiological cases not related to sludge handling) that judgments about the potential significance of heavy metals and organics in sludge are made. Much empirical research on crop uptake of heavy metals has been done but little in the way of correlation of this diet to human health has been firmly established.

The specific concern over heavy metals and toxic substances in the sludge getting into the human food chain is part of a larger environmental concern over human intake of these substances from many different areas of industrialized society (air emissions, pesticide applications, spills, etc.). The current EPA approach of requiring further pretreatment by industries discharging to municipal systems is consistent with trying to reduce the potential future body burdens of these substances for a large population of mankind. Events and further research could show that some significant substance was overlooked or not adequately protected against, but again, there is no firm basis for suggesting so at present.

The central issue for the farming community is the long-term fate of the soils upon which sludge is to be applied. Again, there is no evidence at present to indicate that soils would be irretrievably degraded by the materials in sludge. One significant change in using sludge instead of present agricultural practices would be a reversal of the trend allowing a gradual depletion of soil carbon and micronutrients through the exclusive use of chemical fertilizers. Sludge contains carbon and many micronutrients in abundance that add a measure of water retention and increased friability to the soil structure. As long as current knowledge regarding soil chemistry (Sodium Adsorption Ratio values, limiting amounts of metals and salt that have phytotoxic effects) is followed, there appears to be a significant potential benefit through recycling these sludge materials to the soils and little likelihood of soil damage.

The EIS discusses in Volume I, Section VII the benefits of large scale conservation of non-renewable fossil fuel resources used in the manufacture of fertilizers that this type of project exemplifies. While nitrogen has received the most attention, the supplies of mineable phosphate are similarly limited. Sludge contains a fairly large concentration of phosphorus that could be reused in an agricultural setting.

It is EPA's overall conclusion on this project that recycling of sludge and wastewater nutrients are an eventual certainty and one that should be pursued vigorously now. EPA's best judgment is that this proposal is a reasonable one that is geared to achieving the long-range goal of recycling resources and should be supported.

References listed in this section include published material, unpublished reports and articles, personal communications (telephone, visits, letters, etc.), meeting notes and other sources of data used in the preparation of Volume II.

SECTION D

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This appendix contains the proposed grant conditions which must be implemented by Metro before EPA will allow Step II or Step III grant funds to be allocated for the project.

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APPENDIX A

PROPOSED GRANT CONDITIONS FOR METRO OFFSITE SOLIDS PROJECT

1. The grantee shall agree to complete an industrial pre-treatment survey within a year period following this agreement identifying contributing sources of heavy metals and industrial organics, and likely reductions available with added pre-treatment. The grantee shall agree to provide a report to EPA and the State Water Pollution Control Division containing the above information.

2. The grantee shall agree to hire a qualified archaeologist to monitor the progress of excavation/construction of the offsite solids pipeline from the Metro Central Plant to Colorado Boulevard. In other areas, the grantee shall reimburse the archaeologist to train a qualified Metro employee(s) to recognize archaeological artifacts and to follow the proper procedures in the event of a significant find. Metro will agree to identify an individual(s) responsible for identifying archaeological resources.

The grantee shall take the following steps in the event of an archaeological find:

a. Construction work shall be halted to protect the discovery.

b. The State archaeologist and EPA shall be notified and be allowed to inspect the find.

c. The archaeologist hired to perform the work described above can be used under b., in lieu of the State archaeologist.

d. If a determination is made that construction needs to be halted for more than a single working day, the State Water Pollution Control Division will also be notified. Steps will immediately be taken to protect the archaeological resource as well as to minimize construction delays.

3. The grantee shall agree to develop as part of the Operations and Maintenance Manual for this project, the following conditions:

a. A contingency plan, to be followed in the event of a pipeline disruption/shutdown. The procedure for handling sludge during the downtime, considering the extent of storage available, will be explained. For a pipeline break, the grantee will explain how emergency procedures will be followed to prevent contamination of surface water, groundwater and adjacent properties;

b. A contingency plan explaining how sour digester contents will be handled at the plant or in the event of a need to dispose of soured sludge. Such a plan will detail where the sludge will be buried, the type of equipment to be used, and the proposed rate of application of sludge and critical constituents. The applicant agrees to follow agronomic rates in such a form of emergency disposal;

c. A contingency plan to mitigate windblowing of stockpiled sludge;

d. An emergency procedure to be used in the event the ground water below the site violates drinking water quality standards. The grantee shall specify the manner of removal of contaminated percolate from aquifers including the form of treatment of the contaminated water;

e. A comprehensive ground water monitoring program at the site acceptable to the Colorado Department of Health and Region VIII EPA. A monitoring plan should be laid out and submitted to both agencies for approval. It should include exact locations and depths of monitoring wells, information on how they will be sampled, at what frequency, specifics on the analytical determinations to be made and to whom information will be submitted. The plan should be implemented in time for 6 months of sampling to be accomplished prior to use of the sludge disposal site; and

f. A vector control program for the site.

4. The grantee shall agree to pursue negotiations with the City of Denver Wastewater Control Division and Denver City Parks Department to optimize arrangements between these parties and the Metro District to treat and use sludge in the Metro offsite solids project. The grantee will agree to submit a report outlining the chronology of events, and status of agreement between the two parties prior to final payment of the construction Step III grant.

5. The grantee shall develop an impervious liner on all areas of site B-2 to be used to hold and dry liquid sludge. This shall include any ground areas considered to be at or below the high water mark of the drying beds. The liner shall be of a permanent nature and meet the following performance specifications:

a. The liner shall be the equivalent of a compacted clay layer 12" thick and have a measured permeability after compaction of no more than 1×10^{-7} cm/sec.

b. A suitable cover material the equivalent of at least 12" of a suitable soil type shall be placed over the liner to insure that the liner is not disrupted by subsequent operations.

Further, the grantee shall agree to furnish proof during construction in the form of permeability test data that the performance standards are met. Test data shall be submitted to the EPA, the State Wastewater Pollution Control Division and Adams County. Should a lining and cover material other than stated above be chosen, the grantee will have to submit a lining plan to EPA before construction demonstrating that the above performance standards will be met.

6. The grantee agrees to report any violation of drinking water quality standards to the Colorado Department of Health and the Tri-County Department of Health. Monitoring test data on water quality will also be submitted to these Departments at least quarterly and more often if requested.

7. The grantee will agree to incorporate changes in design to the dried sludge storage portion of the site to preclude or minimize windblowing of stockpiled sludge offsite. The grantee will agree to study the incorporation of earth berms in the storage area design and report its conclusions to EPA before Step III funds are issued.

8. The grantee shall agree to take necessary steps to minimize weed growth on the site. The grantee also agrees to develop a contingency plan to minimize aquatic weed growth in the storage reservoir that could serve as a habitat for waterfowl.

9. The Metro District will agree to retain dried sludge onsite (except for municipal parkland uses or for landfill disposal) until State guidelines for sludge reuse have been formally promulgated.

10. The Metro District will provide adequate warning or otherwise prevent from distribution, the use of the dried sludge product in the following areas:

a. Parkland areas where direct human contact is likely (apart from park personnel);

b. In use on home gardens on leafy vegetables and crops that take up heavy metals, or on crops that could be eaten raw;

c. On irrigated farms, on crops that could be eaten raw;

d. Any widespread use on dryland farms until firm guidelines for the amounts and timing of sludge applications are available; and

e. Any designated or known wetland and floodprone areas.

11. The Metropolitan Denver Sewage Disposal District No. 1 will, insofar as it has influence and authority, limit annual application rates of cadmium in sludges produced by the facility to 2 kg per hectare [1.8 lbs per acre] for dewatered sludges and 1 kg per hectare [0.9 lbs per acre] for liquid sludges applied to cropland. The grantee will agree to recommend this limit for cropland applications.

This appendix contains a copy of the State of Colorado Draft Guidelines for sludge application to land.

STATE OF COLORADO
DEPARTMENT OF HEALTH

Technical Policy

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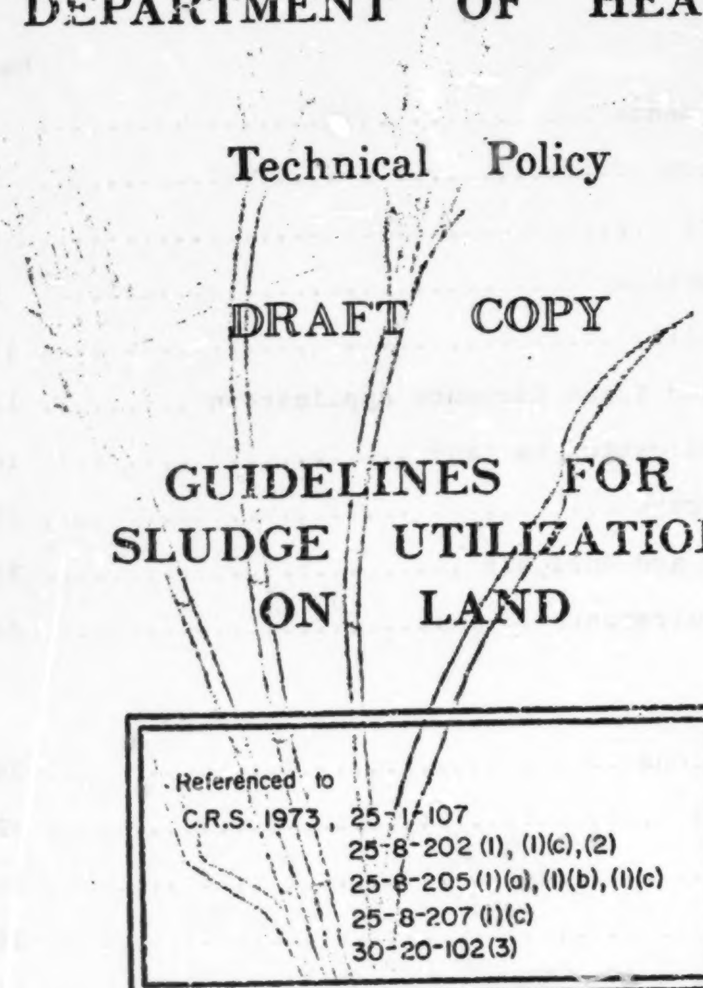

GUIDELINES FOR SLUDGE UTILIZATION ON LAND

Referenced to
C.R.S. 1973, 25-1-107
25-8-202 (1), (1)(c), (2)
25-8-205 (1)(a), (1)(b), (1)(c)
25-8-207 (1)(c)
30-20-102 (3)

GUIDELINES FOR SLUDGE UTILIZATION ON LAND

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Universal Soil Loss Equation

I

ACKNOWLEDGMENTS

The State of Colorado Department of Health wishes to commend the members of the Sludge Task Force for their efforts in the development of these Guidelines. These Guidelines represent the cooperative effort of the entire Sludge Task Force, however, it should be recognized that individual members of the Task Force may not agree with all of the criteria as set forth in this document.

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II

INTRODUCTION

Sludge utilization on land comes at a time when our Nation is valuing its natural and energy resources as never before. The United States Congress passed into law the Federal Water Pollution Control Act Amendments of 1972 as PL 92-500. The Act encourages recycling of sludge through agricultural production and the ultimate disposition of sludge in a manner that will not result in environmental degradation. It is therefore appropriate that Colorado consider carefully the opportunities that are presented by the recycling of sludge onto land. A policy on the utilization of sludge is necessary in order to give direction to the producers, handlers and users.

These guidelines are presented for the utilization of sludge as a recyclable resource. The guidelines address methods of sludge handling, storing and application which provide for maximum reasonable control of potential environmental problems. These guidelines will minimize administrative procedures and allow sludge to be applied more readily at agronomic rates in an environmentally acceptable manner on land throughout the State of Colorado.

The Colorado Department of Health has concluded that an environmentally acceptable alternative for solving sludge management problems is utilization of stabilized sludge on land for agriculture, silviculture or reclamation purposes. This recycling will help to conserve the nutrients, humus, and energy resources of the State while serving its economy.

Sludge contains the concentrated waste of the community and certain components of sludge may be toxic and/or hazardous depending upon their concentration and the intended means of disposal. Application of sludge containing these components, as well as the nutrients nitrogen (N) and phosphorus (P), to the surface and groundwaters must be controlled to prevent degradation in water quality. In addition, the salt content of sludge may inhibit plant growth if applied to soils in high concentrations or at an inappropriate time. Therefore, the quality of the sludge together with agronomic application rates are the keys to an environmentally sound land application program.

The management of sludge generated by wastewater treatment plants in Colorado is subject to the regulations promulgated by the Colorado Board of Health, the Water Quality Control Commission and the Department of Agriculture. Administration and enforcement of the regulations are handled by the Colorado Departments of Health and Agriculture. The program is based upon the best available technology; thus, the main thrust of municipal sludge projects is utilization, as this makes best use of this resource. However, in isolated instances due to economics or an unacceptable sludge, landfilling, land disposal, or other techniques may be the best alternative available.

III
DEFINITIONS

Aerosol - A gaseous suspension of ultra microscopic particles of a liquid or solid.

Agronomic Rates - An application rate of plant nutrients that can reasonably be expected to be taken up and utilized by agricultural crops.

Department - The Colorado Department of Health.

Dried Sludge - Sludge that has been dewatered to 13% solids or greater and can be transported and handled as a solid material.

Incorporation - To mix the sludge with the soil in the upper horizon by such means as subsurface injection, rototilling, discing, or plowing.

Sludge - The accumulated solids resulting from processing sewage in a treatment plant.

NPDES Permit - National Pollutant Discharge Elimination System permit. A permit system established under the authority of the Federal Water Pollution Control Act Amendment of 1972. The permit system is administered by the Colorado Department of Health.

Off-Site Storage - The storage of sludge at a site which is not under the jurisdiction of the Producer and outside of the transporting vehicle.

On-Site Storage - The storage of sludge at a site which is under the jurisdiction of the Producer.

Pathogen - An organism, chiefly a microorganism, including viruses, but also including all forms of animal parasites, that are capable of producing an infection or disease in a susceptible host.

Person - An individual, corporation, partnership, association, state, or political subdivision thereof, federal agency, state agency, municipality, commission, or interstate body.

Producer - Operator of the wastewater treatment facility generating sludge intended for use on land.

Speciality Fertilizers - Dried stabilized sludge distributed primarily for non-farm use, such as gardens, lawns, shrubbery, flowers, golf courses, parks, cemetaries, greenhouses, nurseries, and hydroponics.

Spray Application - Liquid sludge application by sprinkling devices such as center pivots and stationary or movable spray irrigation mechanisms. Spray application does not include application by tank truck spreading devices emitting a stream of less than 10 feet in any direction, and not creating aerosols.

Stabilized Sludge - Liquid or dried sludge from wastewater treatment plants that has been treated to obtain pathogen destruction, volume and weight reduction, odor control, and putrescibility control.

State Waters - Any and all surface and subsurface waters which are contained in or flow in or through Colorado, except waters in sewage systems, waters in treatment works or disposal systems, waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed.

Surface Application - Application of sludge to the land surface by means other than spray application as defined herein.

Trace Elements - Those elements generally found in small concentration in municipal wastewater. Trace elements can be concentrated to higher levels in municipal sludge and can be toxic to plants and animals at higher levels. Those elements of most concern are cadmium (Cd), copper (Cu), lead (Pb), zinc (Zn), and nickel (Ni).

User - The person applying sludge to land.

IV
SLUDGE STABILITY

The purpose for stabilizing sludge is to obtain pathogen destruction, volume and weight reduction, odor control, and putrescibility control to the point where they will not present a public health hazard or nuisance.

Stabilization of sludge can be by chemical treatment, digestion, incineration, heat treatment or composting, the most common form being digestion by aerobic or anaerobic means. These guidelines concentrate on acceptable levels of stabilization through aerobic and anaerobic digestion. Sludge from other stabilization processes and sludge not meeting the following criteria will be considered by the Department on a case-by-case basis. The following are standards for ascertaining the stability of sludge:

A. Aerobic Digestion of Sludge

1. Hydraulic detention time shall be 15-20 days secondary sludge alone; 20-25 days secondary sludge + primary.

2. Volatile solids reduction shall be 40% or greater.

B. Anaerobic Digestion of Sludge

1. Volatile solids reduction shall be 40% or greater. Normally, this can be accomplished in a high rate digestion system after 20 days digestion under mesophilic conditions. For a thermophilic digestion system, 15 days detention is normally required. In a standard rate system, 30 to 40 days detention time is normally required.

2. pH shall be 6.8 to 7.8.

3. Volatile acids concentration shall be less than 500 mg/l. Some variation of this level is possible depending on the alkalinity of the sludge under digestion.

V

SLUDGE QUALITY

Stabilized sludge which is to be applied to land does not require a permit if it does not exceed the levels established as minimum standards. Sludge not meeting these criteria will be considered by the Department on a case-by-case basis.

Minimum Standards
(Dry Weight Basis)

Nutrients

Constituents	Level	Normal Range
Nitrogen (N)	6%	2-6%
Phosphorus (P)	6%	2-6%
Potassium (K)	1%	.25-1%

Trace Elements

Constituents	Level	Normal Range
Zinc (Z)	3000 ppm	500-3000 ppm
Copper (Cu)	1500 ppm	250-1500 ppm
Lead (Pb)	1500 ppm	100-1500 ppm
Nickel (Ni)	1000 ppm	25-1000 ppm
Cadmium (Cd)	30 ppm	5-30 ppm

VI

NUTRIENT & TRACE ELEMENTS APPLICATION

The following guidelines pertain to stabilized sludge. Application rates not requiring a User Permit are limited to agronomic applications as set forth in the following paragraphs. Higher application rates will be considered by the Department on a case-by-case basis.

A. Nutrient Availability by Methods of Application

Different methods of application result in different percentages of ammonia nitrogen in the sludge that will be available to the crop being grown. For design purposes the following percentages should be used.

1. Surface application of liquid sludge without incorporation results in about 80% loss of ammonia nitrogen leaving about 20% of ammonia available for plant growth.

2. Surface application of liquid sludge with immediate incorporation results in 30-70% loss of ammonia nitrogen, depending on how soon incorporation occurs.

3. Subsurface application of liquid sludge results in negligible loss so nearly 100% of the ammonia nitrogen would be available.

4. Some losses of nitrate nitrogen can occur when denitrification proceeds as soils are aerated and then flooded for a period of several days.

5. The Five-Year Cycle of Organic Nitrogen Availability:

In the first year after the sludge application, 20% of the organic nitrogen is available to the crop. In the second year it is assumed that another 10% of the remaining organic nitrogen becomes available to the crop from the sludge applied the first year. Additional sludge can be applied to provide additional available organic nitrogen to the crop. In the third year, 5% of the organic nitrogen applied in the first year will become available. In addition, another 10% will become available from sludge applied during the second year. Again, additional sludge can be applied to provide additional available organic nitrogen to the crop. The fourth and fifth years are similar to the second and third years' pattern with 1.25%, 2.5%, 5% and 10% of the remaining fraction of the organic nitrogen becoming available to a fifth year crop from the first, second, third and fourth year applications, respectively (see Table 1 of the Appendix). After the fifth year it is thought that no appreciable organic nitrogen will become available for crop usage from the first year application. Five years or more after application the sludge will not yield appreciable nitrogen for crops. Calculations should be made to determine in what year equilibrium will be reached for any design scheme. Sample calculations are included in the Appendix.

B. Summary of Factors Governing Loading Rates:

The basic premise governing sludge application to agricultural land is that rates shall be based upon agronomic requirements for crop fertilization. If necessary, supplemental fertilizer should be applied to balance the nutrient supply required by the crop.

There are three major areas of consideration: nitrogen, phosphorus, and trace elements.

1. Nitrogen: In the short-range (five years), nitrogen in the sludge is considered to be the limiting factor to application rates. In a typical Colorado situation, maximum loading rates of sludge applied to the land are based on the nitrogen required for growing a crop. Sludge shall not be applied at rates that exceed the nitrogen fertilization rate (plus losses) for the crop grown as specified in Table 2 in the Appendix.

2. Phosphorus: In the long run, phosphorus content of the soil may govern loading rates for the sludge. After five years the phosphorus level in the soil should be determined and sludge application be reduced or ceased if the phosphorus content in the soil, as determined by the Olsen Bicarbonate Test, exceeds 400 pounds per acre.

3. Trace Elements: For the short-range, the loading rates calculated to provide nitrogen for growing crops usually result in the application of trace elements to the soil in amounts that would not be harmful from a water and food chain standpoint. In the long run, the trace elements content in the soil should be monitored for trace element buildup. The frequency of monitoring of the soil will be dependent upon the quality of the sludge. Monitoring of the trace elements in the sludge soil mixture should be done once every five years starting with the fifth year of continuous application.

Most of the trace elements in sludge applied to soils are retained in surface soils; only small amounts may go into solution. Thus, pollution potential for surface waters is greater than that of ground water. Since trace elements applied to the soil are largely concentrated in the surface, drainage from surface soils into surface waters may contribute to pollution of state waters. Concentration of trace elements in water considered to be toxic to aquatic organisms are, in many cases, lower than those considered toxic to higher plants and animals. Since these tolerances are so low, surface run-off of either sediment or solution into surface waters must be held to a minimum.

VII
SLUDGE APPLICATION ON LAND

It is of vital importance that a sludge application program be carefully managed and regulated to avoid ground and surface water pollution and potential health and aesthetic problems. All sludge which is to be applied to land must be stabilized.

A. General Considerations

1. Crops: Sludge shall not be applied directly to crops that could be eaten raw. Stabilized sludge which has been stored on-site (i.e., a site under the jurisdiction of the Producer) for a minimum of one year prior to application may be applied to land where crops are produced that could be eaten raw.

2. Cropping: Sludge shall not be applied to land which will lie fallow for more than one cropping cycle (maximum one year and one-half). Where liquid sludge is applied to pasture crops, it is recommended that livestock not be allowed to graze on the pasture until the sludge has been washed from the foliage by rainfall or irrigation.

3. Precipitation: Sludge shall not be applied during precipitation or when precipitation is imminent.

B. Application Methods

1. Incorporation: Incorporation is the preferred method of application for conservation of nitrogen. It also minimizes potential aesthetic problems. No User Permit is required when greater than 20 feet from occupied dwellings.

2. Spray Application: A User Permit is required. The Department will review each spray application request on a case-by-case basis.

3. Ridge and Furrow Application: A User Permit is required. The Department will review each ridge and furrow application request on a case-by-case basis.

C. Site Considerations

1. Slope: For surface application, the slope of the receiving land must not exceed 5%, or the land must have sufficient soil conservation measures established that average annual soil losses will be less than five tons per acre, as determined by the Universal Soil Loss Equation (USLE, see Appendix).

   However, if the sludge is incorporated into the soil, it may be applied on slopes of up to 8% regardless of the annual soil loss. For slopes in excess of eight percent, the annual soil loss cannot exceed five tons per acre.

   No User Permit is required for these slope conditions.

2. Ice-Covered, Snow-Covered or Frozen Land: Sludge may be applied on ice-covered, snow-covered, or frozen land without a User Permit provided the land does not exceed a 5% slope. If the land does not exceed a 5% slope, sludge may be applied provided the annual soil loss does not exceed five tons per acre as determined by the USLE.

3. Water-Ponded or Saturated Land: Sludge shall not be applied on water-ponded or saturated land.

4. Depth to Mean Annual Groundwater Table: No User Permit is required when the mean annual groundwater level is greater than 7 feet from the surface of the land.

5. Distance From a Domestic Water Well: No User Permit is required when greater than 150 feet.

6. Flood Plain: No User Permit is required when outside of the 10-year (10%) flood plain.

7. Soil Texture: Application of sludge on land comprised of loamy sand or coarser material, as described in the U.S. Department of Agriculture Textural Chart, requires a User Permit. See Figure 1 of the Appendix.

VIII

SLUDGE STORAGE

Unstabilized sludge may be retained at the wastewater treatment facility while awaiting stabilization provided the facilities used for retention of said sludge have met the appropriate requirements of the Department. This chapter of the guidelines deals specifically with the storage of stabilized sludge.

All sludge which is to be stored until use must be stabilized. A prime consideration in the storage of sludge is the protection of state waters from pollution. Sludge should never be stored on a site where the drainage therefrom could pollute surface or ground water.

Other considerations regarding sludge storage are to ensure that the pathogenic organism content has been reduced and to minimize insect and rodent infestation and odors to a point where they will be inoffensive. Control measures must be instituted if problems exist in the operation of the storage site. Factors that will affect the odors emitted from a sludge storage area include the degree of stabilization, the volume of sludge stored and climatic conditions. Total odor emissions are directly proportional to the effective exposed surface area of the storage facility. For liquid sludge, wave action or turbulence increases the total effective surface area and therefore total emission. With regards to climatic conditions, odors can be intensified through precipitation, increase in temperature, wind action and atmospheric inversions.

Sludge storage sites must comply with local zoning and adopted comprehensive land use plans.

Storage of sludge is permissible provided that the following criteria are followed:

A. On-Site Storage of Stabilized Sludge (i.e., Storage at a Site Which is Under the Jurisdiction of Producer)

1. Dried Sludge:
   a. Sludge may be stored on properly designed sludge drying beds approved by the Department.

   b. Dried stabilized sludge meeting established minimum standards shall be stored in a manner and location so as to protect state waters from pollutants.

2. Liquid Sludge:
   a. Liquid sludge may be stored in properly designed sludge drying beds approved by the Department.

   b. Storage of liquid sludge will be permissible only in properly designed storage facilities approved by the Department.

B. Off-Site Storage of Stabilized Sludge (i.e., Storage at a Site Which is Not Under the Jurisdiction of Producer)

1. Dried Sludge:
   a. Sludge shall be stored in a manner and location so as to protect state waters from pollutants.

   b. Sludge shall be stored in a manner and location so as to prevent nuisances.

2. Liquid Anaerobically Stabilized Sludge:
   Liquid anaerobically stabilized sludge must be stored by enclosing the sludge in a structure approved by

the Department and not directly accessible to the outside atmosphere. Closed storage facilities shall have an air breather vent pipe(s) properly capped to preclude the entrance of precipitation. Minimum height from top of vent to ground level shall be ten (10) feet. Appropriate signs shall be posted in the immediate vicinity of the storage facility which as a minimum must state, "DANGER, NO SMOKING."

Closed facilities having an effective volume in excess of one (1) million gallons shall incorporate into the vent design a device to minimize point source emissions of odors.

Storage facilities shall be properly designed to prevent explosive situations. Electrical equipment in the immediate vicinity of the closed storage facility shall comply with the National Board of Fire Underwriter's specifications for hazardous connections. Any forced air ventilation equipment shall be fabricated from non-sparking material. Access shall be provided for all closed liquid storage facilities. Entrance into such facilities shall not be done without the use of self-contained oxygen-supplying equipment approved by Colorado Occupational Safety and Health Administration.

Closed liquid storage facilities must be constructed with relatively impermeable materials (clay, concrete, or equivalent).

Under isolated conditions and upon approval of the Department, open storage may be permissible.

3. Liquid Aerobically Stabilized Sludge:
   a. The storage site shall be isolated from residential and commercial developments.

   b. The storage facility shall be of a design approved by the Department.

   c. Aeration equipment shall be provided to maintain measurable amount of dissolved oxygen.

IX
MONITORING AND ANALYSIS

Sludge monitoring and analysis is the responsibility of the Producer. A Producer of sludge which is to be used in land application must monitor and analyze the sludge according to conditions set forth in the NPDES permit. In developing a sludge utilization program, representative sludge samples and adequate analyses of the sludge are required. To obtain a representative sample, a number of samples collected periodically over a twenty-four hour period should be composited. Samples should be stored in sealed glass or plastic bottles in a refrigerator and analyzed as soon as possible. It is beyond the scope of this document to give details on how to conduct analyses of sludge. The methods are set forth in the documents listed below. Certain analyses, particularly of the trace elements, require complicated instrumentation and trained technicians. Except for larger organizations, these analyses should not be undertaken by the entity. Care must be taken with the nitrogen analyses, as ammonia volatilizes readily from the sample and an underestimate of the nitrogen content of sludge can result. Acceptable methods of analyses are contained in the following documents: (1) United States Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes (1974), (2) American Public Health Association, Standard Methods for the Examination of Water and Wastes (Current Edition).

A. Frequency of Sampling

1. All plants with a treatment capacity of up to 10 million gallons a day (10 MGD) require a minimum of one sludge analysis quarterly.

2. All plants with a treatment capacity of 10 million gallons a day (10 MGD) or more require a minimum

of one sludge analysis monthly.

3. The Department may require increased frequency of sludge analysis in specific cases.

B. Collection of Samples

1. Sludge Storage or Drying Basins (Solid and Semi-Solid Sludge)

   a. Collect samples during dry periods and not sooner than 48 hours following the last measurable precipitation. Samples should not be collected sooner than 48 hours following a thaw.

   b. To obtain a representative sample from a solid or semi-solid sludge which is evenly dispersed in a storage basin or drying area, the area is divided into six equal sections. Core samples of approximately 1/2 pound each are taken from the centers of these sections. The core samples are then composited. The composite sample shall be refrigerated at 4°C and the required analyses run as soon as possible.

   c. To obtain a representative sample from piled or windrowed sludge, take at least six core samples of approximately 1/2 pound each from representatively random sections of the piles or windrows and composite.

2. Digesters and Storage Tanks (Liquid Sludge)

   A composite sample should be procurred and the sample should be representative of the sludge which has been pumped from the digester or from the storage tank over a 24-hour period. This sample should consist of a minimum of three grab samples of 500 ml each taken at the start, middle and end of the pumping cycle. If pumping is continuous or with brief interruptions during the day, grab samples of 250 ml each should be taken hourly and composited. The composite sample shall be refrigerated at 4°C and the required analyses run as soon as possible.

C. Analyses Required

1. Percent Total Solids
2. Percent Volatile Solids
3. pH
4. Volatile Acids (for liquid anaerobic sludge)
5. Ammonia Nitrogen
6. Organic Nitrogen
7. Total Nitrogen
8. Total Phosphorus
9. Total Potassium
10. Conductivity
11. Trace Elements (Total)
    a. Copper
    b. Zinc
    c. Nickel
    d. Lead
    e. Cadmium
12. The Department may require additional analyses, particularly for those plants providing wastewater treatment for industry.

X
PERMIT REQUIREMENTS

A. Producer

1. The Producer has the responsibility for the sludge up to the point of acquisition by the User.

2. Where the Producer of sludge possesses a NPDES Permit, the permit will be amended to include the requirement regarding the disposition of the sludge. The permit will reflect the analyses which are required, the frequency of the analyses and the method for reporting the results.

3. Where the Producer of sludge is not required to possess a NPDES Permit, he shall contact the Department to obtain a special permit relative to the disposition of sludge. The permit will reflect the analyses which are required, the frequency of the analyses and the method for reporting the results.

4. The Producer is required to maintain dried and liquid stabilized sludge distribution records for all sludge produced and distributed. The Producer shall file these records with the Department on a quarterly basis. The records of the Producer shall be available to the Department for periodic review upon request.

5. Sludge that is marketed must be registered with the Colorado Department of Agriculture.

6. Failure of the Producer to acquire a valid permit will subject the Producer to prosecution under Colorado State law.

B. User

1. No User Permit is required when the sludge and its application complies with all of the established minimum standards set forth in these guidelines.

2. No User Permit is required when the sludge is used as a speciality fertilizer, providing that the sludge has received an on-site storage time of not less than one year including the time required for drying unless thermally processed to ensure pathogenic destruction.

3. A User Permit is required when the sludge or its application is not in compliance with all of the established minimum standards as set forth in these guidelines.

4. Failure of the User to acquire a valid permit when a permit is required will subject the User to prosecution under the Colorado State law.

APPENDIX

Example Calculation For Determination Of Nitrogen Requirements For Sludge Application To Land

The following procedures are recommended for calculating sewage sludge application rates for a field if you have a SOIL TEST REPORT or if you do not have a SOIL TEST REPORT.

WITH SOIL TEST -- (This is most desirable)

A. Obtain nitrogen recommendation in #/acre = (A) from test results.

B. Calculate the available N from NH_4 in sludge added for the current year using the following formula:

$$\%NH_4\text{-N in sludge} \times \frac{2000\ \#/\text{ton}}{100\ (\text{conversion from }\%)}$$

$$= \%NH_4\text{-N} \times 20 = (\underline{B})\ \#NH_4\text{-N/ton sludge}$$

If surface applied and not incorporated until dry, reduce this value (B) to one-fifth or multiply it by 1/5 or 0.2.

C. Calculate the available N from organic N in sludge added for the current year using the following formula:

$$\%\text{organic N} \times \frac{2000\ \#/\text{ton}}{100\ (\text{from }\%)} \times 0.2\ (\text{mineralization rate, }20\%)$$

$$= \%\text{ organic N} \times 4 - (\underline{C})\ \#\text{ organic N/ton}$$

D. Residual sludge N in soil = (D) # N/A

If soil has received sludge in the past five years, calculate residual N from Table 1.

E. Sludge application rate, tons/acre (E)

$$= \frac{\text{Nitrogen recommendation, \#/acre - Residual N, \#/acre}}{\text{\# available N/ton sludge}}$$

$$= \frac{(A) - (D)}{(B) + (C)}\ \text{tons/acre}$$

Example Calculation

Corn; Weld County; yield potential - very high

Soil test results	Fertilizer recommendations
Texture: clay loam	Corrective and Maintenance
Organic matter: 1.5%	N: 160 #/acre
NO_3-N: 12 ppm	

Sludge Analyses

NH_4-N = 1.5% Organic N = 2.5%, Surface application-3rd year; 5 tons/acre applied in year 1 and 2.

1. Fertilizer N recommended = 160 #/acre = (A)
2. Available N from NH_4 in sludge (current year)
   1.5 (%NH_4-N) x 20 x 0.2 (for surface application)= 6 #/ton = (B)
3. Available N from organic N in sludge (current year)
   2.5 (% organic N) x 4 = 10 #/ton = (C)
4. Residual N, from Table 1 for 2.5% organic N
   Sludge added 1 year previous 5 tons/acre x 5 = 25 #/acre
   Sludge added 2 years previous 5 tons/acre x 2.5 = 12.5 #/acre

   Total residual N = 25 + 12.5 = 37.5 #/acre = (D)
5. Sludge application rate = $\frac{(A) - (D)}{(B) + (C)} = \frac{160 - 37.5}{6 + 10} =$

   7.66 or about 8 tons/acre

WITHOUT SOIL TEST -- N requirement can be obtained from Table 2 instead of a SOIL TEST REPORT (This is not as desirable as getting the N requirement from a soil test).

A. Obtain N requirement from Table 2 = (A) #/acre

B & C. Calculate available N in sludge as in items B and C above (B) and (C) #/acre.

D. Residual sludge N in soil = (D) #/acre
If soil has received sludge in past three years, calculate residual N from Table 1 as in item D above.

E. Sludge application rate, tons/acre

$$= \frac{\text{\# crop N requirement - \# N residual N}}{\text{\# available N in sludge}} = \frac{(A) - (D)}{(B) + (C)} = \text{tons/acre}$$

Example calculation

From Table 2, N needed for 120-140 bushels of corn
= 170# N per acre = (A)

The remainder of the calculations are as shown previously.

Table 1. Release of available N (per ton of solids) during sludge decomposition. This table can be used to calculate D in the formulas.

Years after Sludge Application	Mineralization Rate	% N in Sludge 2.0	2.5	3.0	3.5	4.0	4.5	5.0
		# of N available						
1st	20	8	10	12	14	16	18	20
2nd	10	4	5	6	7	8	9	10
3rd	5	2	2.5	3.0	3.5	4	4.5	5
4th	2.5	1	1.25	1.5	1.75	2.0	2.25	2.5
5th	1.25	0.5	0.62	0.75	0.87	1.0	1.12	1.25

Example -- If you were calculating the amount of available N that would be released from the organic N contained in the sludge added in previous years (Residual N or D in the formula) for the current year (C in the formula) this table could be used.

Assume that 5 tons of sludge had been added each year for 4 previous years and you want to know how much residual N will be supplied on the 5th year by the previous sludge additions. If the sludge had 2.5% organic N, then 0.62#, 1.25#, 2.5# and 5# would be supplied from 1 ton of sludge applied during the 4 previous years. That would be a total of 9.37# of N per ton of sludge. Since 5 tons of sludge were added each year, then 9.37 x 5 = 46.85# of N would be available during the 5th year from the previously applied sludge.

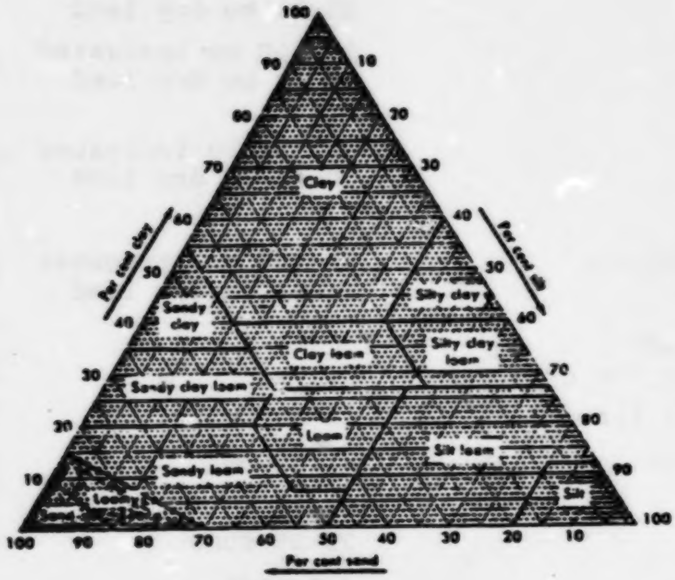
TABLE 2. Nitrogen Requirements for Colorado Crops (Pounds of N)

Crop	Typical Yields Per Acre	Available N (#)	lbs/Acre
Corn for grain	120-140 bu	1.3/bu	170
Corn for silage	25-30 tons	7.5/ton	200
Wheat (1)	60-80 bu irrigated 20-30 bu dry land	2.3/bu	160 60
Oats (1)	80-100 bu irrigated 30-40 bu dry land	1.1/bu	100 40
Barley (1)	80-100 bu irrigated 30-40 bu dry land	1.5/bu	140 50
Malting barley (1)	80-100 bu irrigated 30-40 bu dry land	1.3/bu	120 45
(irrigated) Grain sorghum for grain	8000#	2/100#	160
Grain sorghum for silage	15-20 tons	7.5/ton	130
Forage grasses	4-6 tons	40/ton	200
Potatoes	12-15 tons	10/ton	140
Sugar beets	20-25 tons	6/ton	140
Alfalfa (2)	4-6 tons	(2)	200
Clovers (2)	4-6 tons	(2)	200
Dry beans (2)	2000#	(2)	200

(1) If the straw is removed

(2) Legumes can obtain most of their N from the air and are normally not fertilized with N. However, if included in a crop rotation with N using crops, they will use the available N in the soil and will fix very little N from the air. Therefore, it can be assumed that they will remove as much N as corn for grain in the same rotation.

Figure 1. Textural classification chart (U.S. Department of Agriculture) and comparison of particle size scales.


100
90
80
70
60
50
40
30
20
10
Per cent clay
Per cent silt
Per cent sand
Clay
Sandy clay
Silty clay
Clay loam
Silty clay loam
Sandy clay loam
Loam
Silt loam
Sandy loam
Silt
Loamy sand
Sand
100 90 80 70 60 50 40 30 20 10

Sand—2.0 to 0.05 mm. diameter
Silt—0.05 to 0.002 mm. diameter
Clay—smaller than 0.002 mm. diameter

DRIED STABILIZED SLUDGE
USER PERMIT

1. Date: ____________
2. Producer: ________________________________ Address: ________________________
3. Name of User: ____
4. Address of User: ____
5. Phone Number of User: __________________
6. Location Where Sludge is to be Used: _____________________________________
7. Distance (feet, yards, miles) to nearest: (a) Stream_______________; (b) Pond _______________; (c) Well ________________; Other Water Supply, (describe) ____
8. Amount of Sludge Desired (Dry Tons): __________________
9. Actually Loaded (Dry Tons): __________________________
10. Number of Acres to Receive Sludge ______________________
11. Application rate (Dry Tons per Acre) __________________
12. Describe Use(s) of Sludge (e.g. Soil Conditioning of Farmland, Garden, Yard, Reclamation of Nutrient Deficient Land, Other:
____
____
13. Manner in Which Sludge is to be Applied:
____
____
14. Will Sludge be Stockpiled Before Application: Yes No (Circle One)
15. Estimated Length of Time Sludge is to be Stockpiled: ____________________
16. Type of Crops to be Grown on Sludge Conditioned Land: __________________
____
____
____

The information set forth above is true and correct to the best of my knowledge.

______________________________ User's Signature

______________________________ Producer's Signature

Dept. Approval: ______________________________
Representative's Signature

LIQUID STABILIZED SLUDGE

USER PERMIT

1. Date: ____________
2. Producer: ______________________________ Address: ____________________
3. Name of User: ____
4. Address of User: ____
5. Phone Number of User: ____________
6. Location Where Sludge is to be Used: ____________________________
7. Distance (feet, yards, miles) to nearest: (a) Stream ______________
(b) Pond __________; (c) Well __________; (d) Other Water Supply,
(describe) ____
8. Amount of Sludge Desired (Dry Tons): ____________________
9. Actually Loaded (Dry Tons): ____________________
10. Number of Acres to Receive Sludge ____________________
11. Application Rate (Dry Tons per Acre ____________________
12. Describe Use(s) of Sludge (e.g. Soil Conditioning of Farmland, Garden, Yard, Reclamation of Nutrient Deficient Land, Other):
____
____
13. Manner in Which Sludge is to be Applied and/or Incorporated:

APPLICATION
(Check One)

____ Splash plate
____ Spray irrigation equipment
____ Other surface application
____
(Specify)
____ Direct injection of sludge into the soil

INCORPORATION
(Check One)

____ Discing
____ Chisel Plowing
____ Mold Board Plowing
____ Rototilling

14. Will Sludge be Stored Before Application: No ____ Yes ____
15. Estimated Lenght of Time Sludge is to be Stored: ____________________
16. Types of Crops to be Grown on Sludge Conditioned Land: ______________
____
____

The information set forth above is true and correct to the best of my knowledge.

____
User's Signature

____
Producer's Signature

Dept. Approval: ______________________
Representative's Signature

PRODUCER DRIED STABILIZED SLUDGE

INFORMATION SHEET

1. Date: ____________
2. Producer: ________________________________ Address: ________________
3. Name of User: ____
4. Address of User: ____
5. Phone Number of User: ________________
6. Location Where Sludge is to be Used: ______________________________
7. Distance (feet, yards, miles) to nearest: (a) Stream__________; (b) Pond ______________; (c) Well ______________; Other Water Supply, (describe) ____
8. Amount of Sludge Desired (Dry Tons): ____________
9. Actually Loaded (Dry Tons): ________________
10. Number of Acres to Receive Sludge ______________
11. Application rate (Dry Tons per Acre) ____________
12. Describe Use(s) of Sludge (e.g. Soil Conditioning of Farmland, Garden, Yard, Reclamation of Nutrient Deficient Land, Other:

    ____

    ____

13. Manner in Which Sludge is to be Applied:

    ____

    ____

14. Will Sludge be Stockpiled Before Application: Yes No (Circle One)
15. Estimated Length of Time Sludge is to be Stockpiled: ______________
16. Type of Crops to be Grown on Sludge Conditioned Land: ______________

    ____

    ____

    ____

The information set forth above is true and correct to the best of my knowledge.

______________________ User's Signature

______________________ Producer's Signature

PRODUCER LIQUID STABILIZED SLUDGE
INFORMATION SHEET

1. Date: ____________
2. Producer: ______________________ Address: ____________
3. Name of User: ______________________________
4. Address of User: ______________________________
5. Phone Number of User: ____________
6. Location Where Sludge is to be Used: ____________________
7. Distance (feet, yards, miles) to nearest: (a) Stream ____________
(b) Pond ____________; (c) Well ____________; (d) Other Water Supply, (describe) ______________________________
8. Amount of Sludge Desired (Dry Tons): ____________
9. Actually Loaded (Dry Tons): ____________
10. Number of Acres to Receive Sludge ____________
11. Application Rate (Dry Tons per Acre ____________
12. Describe Use(s) of Sludge (e.g. Soil Conditioning of Farmland, Garden, Yard, Reclamation of Nutrient Deficient Land, Other):
____
____
13. Manner in Which Sludge is to be Applied and/or Incorporated:

APPLICATION
(Check One)

____ Splash plate
____ Spray irrigation equipment
____ Other surface application
____
(Specify)
____ Direct injection of sludge into the soil

INCORPORATION
(Check One)

____ Discing
____ Chisel Plowing
____ Mold Board Plowing
____ Rototilling

14. Will Sludge be Stored Before Application: No ____ Yes ____
15. Estimated Lenght of Time Sludge is to be Stored: ____________
16. Types of Crops to be Grown on Sludge Conditioned Land: ____________
____
____

The information set forth above is true and correct to the best of my knowledge.

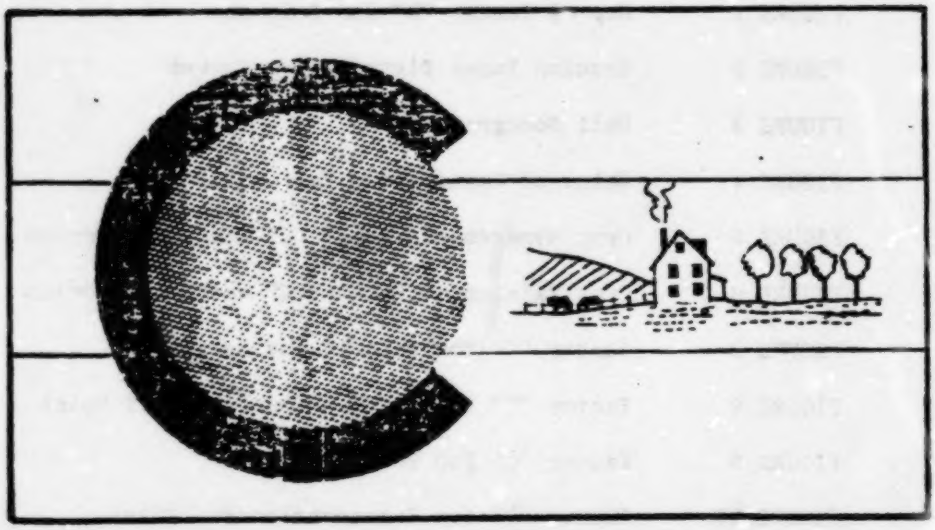
____
User's Signature

____
Producer's Signature

UNIVERSAL
SOIL LOSS
EQUATION

TECHNICAL NOTE 50

(REVISED JAN 1977)



COLORADO
SOIL CONSERVATION SERVICE
U.S DEPARTMENT OF AGRICULTURE

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TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

AGRONOMY NOTE #50 (revised) January, 1977

To: All Offices

From: Arnold D. King, Agronomist

UNIVERSAL SOIL-LOSS EQUATION

The Universal soil-loss equation is a means of estimating soil loss and evaluating conservation alternatives on a quantitative basis. It was developed primarily for use in predicting sheet and rill erosion on non-irrigated croplands. It does not account for gulley erosion and does not calculate sediment yield.

Recent developments, particularly in "C" factors has expanded its use to estimating soil loss on various types of project areas.

SECTION I

The Universal Soil-Loss Equation

The soil-loss equation is

$$A = R\ K\ L\ S\ C\ P$$

Where A is the soil loss (Tons/Acre/Year)

R, rainfall factor

K, soil erodibility factor

L, length of slope)
) Combined into an LS factor
S, percent slope)

C, cropping management factor

P, erosion control practice factor

Each of the five factors mentioned above are multiplied together to give the answer "A, Soil Loss" in terms of Tons/Acre/Year. Therefore, the smaller the factors, the smaller the amount of soil loss from water erosion.

It must be recognized that the USLE is an empirical formula; based on research, experience and observation. Good judgement must be exercised in deriving values for each of the factors.

R (rainfall) factors are assigned by geographical regions based on weather data furnished by the U. S. Weather Service. R values are based on rainfall amount, time, and intensity. In the mountains, R values were computed primarily for valley areas and have been increased to account for run-off from snow melt.

An iso-erodent map, "R" factor map, has been developed for the entire state. In the mountain regions it was necessary to generalize to a large extent because of the wide variation in rainfall patterns. See figure 1.

The rainfall information has been plotted on curves for various locations. This information can be used to predict erosion for periods less than 12 months. See figure 2. This will be discussed in more detail in the example section of this technical note.

K (soil erodibility) factors are assigned each soil series. Soil Scientists have developed a listing of "K" factors for all soil series being mapped in Colorado. The "K" factor will change for a given soil series as different horizons are exposed by a land disturbing activity. Therefore it was necessary to assign "K" factors for the various soil horizons occuring in a soil series.

K values are determined by use of a nomograph. See figure 3. Refer to "Erodibility and Loss Factors for Soils of Colorado" to determine "K" factors for soils of Colorado. An SCS soil scientist should be consulted for assistance, if additional "K" values are needed.

LS (length and percent slope) factors account for the length and percent slope. These factors will be taken from Table 4.

Length of slope begins at the top of the micro-watershed. This is usually the top of a hill, ridge, terrace, or diversion. The length of slope is considered to end for a given field at one of the following places: (1) the point where the slope decreases to the extent that deposition occurs (2) the point where runoff enters a well-defined channel, gulley, terrace, or diversion or (3) where water leaves the field.

If terraces or diversions are used to achieve the proper LS factor for the given situation, they must be constructed in accordance with appropriate engineering Sandard and Specifications.

Uniform slopes are ideal for use in the USLE, but are uncommon. Slopes are usually convex (steepening substantially toward the lower end) or concave (flattening toward the lower end).

When the lower end of the slope is steeper than the upper end (convex-slope), the gradient of the steeper segment should be used with the overall slope length to enter the LS chart.

On a concave slope, deposition may occur at the lower end of the slope. In such cases, the appropriate length and gradient are those of that segment of the slope that is above the point where it flattens enough for deposition to occur.

If the field is divided into segments according to degrees of erosion, each segment must be treated separately as needed. If the field remains as one segment, it must be treated to control the most severely eroding areas.

C (cropping - management) factors are the ratios of soil losses from lands cropped under specified conditions to the corresponding losses from tilled, continuous fallow.

Cropland C values will be taken from Figure 5 or 6. Select the appropriate charts, then select the correct cropping sequence for the given field. It will be necessary to exercise good judgement when selecting C values. All crops are not listed, because many are similar. There would be no appreciable difference between wheat and barley. Also, there would be no appreciable difference between corn harvested as silage and sorghum; planted in rows, harvested as bundles.

If additional C values are needed, notify the State Agronomist. He is responsible for their computation.
"C" factors for land uses other than cropland are included on Figures 7, 8, and 9. The percent ground cover is the primary item to consider because a slight change in percent ground cover will result in a significant change in the erosion prediction.

Figure 8 was developed for use on critical areas and various land disturbing projects. It should be recognized that straw mulch begins to lose its effectiveness after a few months depending on moisture, temperature, soils, etc.

P (erosion control practices) factors are support practices which slow runoff water and thus reduce the amount of soil it can carry. The P factor is the ratio of soil loss with the supporting practice to that of soil loss with up-and-down-hill culture.

Read the appropriate P value for each field from figure 10. Values are based on percent slope and method of farming.

Definitions:

(a) Contour stripcropping is alternate strips of a sod producing crop and a cultivated crop. Strips of sod must be as wide as the strip of cultivated crop.

(b) Cross slope farming with strips is similar to Item (a), above, but is not on contour.

(c) Contour farming is tillage and planting on the contour, but does not necessarily involve strips.

(d) Cross slope farming without strips is simply farming a field cross slope.

(e) Up and down hill farming is farming without regard to slope.

Figure 10 provides the values for factor P.

SECTION II

Procedure for Estimating Average Annual Soil Loss Resulting From Water Erosion (Sheet and Rill)

R-rainfall factor: "R" values for each county are shown on the state map (Figure 1). See Section III to determine "R" for only a portion of the year.

K-soil erodibility factor: "K" values for each soil are shown in the field office Technical Guide, or may be included on a chart supplementing this document.

L-slope length factor: Estimate slope length in the field. Slope length is the distance from the point of origin of overland flow to the point where (1) slope decreases to the extent that deposition begins or (2) runoff enters a defined channel. If the field is terraced, L is the distance between terraces.

S-slope gradient factor: Estimate percent of slope in the field.

LS-Slope-Effect factor: Values for slope length and slope gradient are combined into the Slope-Effect factor (LS). When slope length and gradient have been determined, the LS value is found Figure 4.

C-cropping-management or plant cover factor: Figures 5 and 6 show cropping-management "C" factors for various crops and tillage practices in rotation on cropland. Yearly "C" values were combined to calculate "C" values for various crop rotations. To determine factor "C" for land uses other than cropland, refer to Figures 7, 8, and 9.

P - erosion control practice factor: Figure 10 shows values of P for cross-slope farming, contouring, and stripcropping.

Example Situation:

A farmer is growing winter wheat at Craig, Colorado. He uses a wheat fallow rotation, plows with moldboard in the fall and by planting time, no residue remains on the soil surface. The soil map shows that the dominant soil in the field is Hesperus loam. Field examination shows the slope length is approximately 400 ft and the slope is approximately 6%. The farming operations are generally up and down the slope. What is the predicted average annual soil loss in tons per acre?

Solution:

Use the Universal Soil Loss Equation A = RKLSCP or Soil-Loss calculator.

Step 1

Determine "R" from Figure 1. R - 40

Step 2

Determine "K" from "Erodibility and Loss Factors for Soils of Colorado".
K = .28

Step 3

Determine the combined "LS" factor from Figure 4. LS = 1.4

Step 4

Determine factor "C" from Figure 6 Wheat-Fallow, Fall plowing, 150 lbs residue/AC. C = .46

Step 5

Determine factor "P" from Figure 10. Up and down slope farming operations. P = 1.0

Step 6

Multiply (R=40) x (K = .28) x (LS = 1.4) x (C = .46) x (P = 1.0)
The product of these factor values indicate that approximately 7.2 tons/AC/Yr of erosion occurs on the field.

Planning Considerations:

The soil loss tolerance, T Factor, for Hesperus loam is 5 tons. The predicted soil loss of 7.2 tons/Ac/Yr is excessive and in order to have an adequate resource management system the predicted soil loss from wind and water must be reduced to 5 tons/AC/Yr or less. Wind erosion is not considered significant in this county so practices that will reduce water erosion will be the primary concern.
Water erosion can be reduced by the following:

1. Leaving additional crop residue
2. Changing the cropping system
3. Shorten the slope with diversions or terraces.
4. Install a strip cropping system
5. Perform contour farming in combination with terraces. See footnote 1/ Figure 10.

The most acceptable solution to the erosion hazard would probably be to improve the residue management program. For example, if the farmer would agree to leave his crop residue standing through the winter, plow in the spring leaving approximately 500 lbs of residue at planting time, his soil loss would be reduced to 3.7 tons/Ac/Year.

SECTION III

Predicting Soil Loss for Periods Less Than 12 Months

The information in this section provides a procedure for predicting soil loss for any period of time within a year. For example, project areas may be bare for a short period of time and then be mulched or protected by temporary seeding. To accomplish this it is necessary to determine the percentage of factor "R" that will occur during a given time span of the year. Figure 2 can be used to determine the adjusted factor "R".

Example Situation

A critical area treatment project is planned in Fremont county. The entire drainage area of 30 acres will be shaped, mulched and seeded. Sediment basins will be constructed to retain the predicted amount of sediment. The structures will be designed to retain sediment for a two year period beginning immediately after shaping. What is the predicted soil loss during the two year period? Can we convert this to sediment yield?

Step 1

Determine values for R,K,LS, and P. R = 40, K = .34, LS = 6.0(60ft x 30%), C (To be determined for each stage), P = 1.0

Step 2

Determine adjusted "R" values by use of E.I. distribution curves. See Figure 2, then determine "C" values for each cover condition.

1st Stage - Bare soil, August 1st to November 1st.
R = 8.8 (40x22%) x K = .34 x LS = 6.0 x
C = 1.0 (bare ground) x P = 1.0 = 17.9 Tons/Ac

2nd Stage - Mulch and seed, November 1st to August 1st
R = 31.2 (40x78%) x K = .34 x LS = 6.0 x
C = .06 (See Figure 8) x P = 1.0 = 3.8 Tons/Ac

3rd Stage - Growing grass, 2nd year, August 1st to August 1st
R = 40 (Full year) x K = .34 x LS = 6.0 x C = .07 (50% ground cover including mulch) x P = 1.0 = 5.7 tons/Ac

Step 3

The predicted soil loss for the first two years after construction is 822 tons (27.4 x 30 Ac). This data is based on average climatic conditions, so the engineer may want to apply a safety factor. A geologist or engineer can use the predicted soil loss, determine a sediment delivery ratio and calculate the amount of sediment the structure will need to retain. Refer to Section IV for additional guidance.

SECTION IV

SOIL LOSS VS. SEDIMENT YIELD

Sediment yield is equivalent to the gross erosion minus what is deposited enroute to a given point. Sediment yield estimates are needed to evaluate sediment damage and to determine sediment design requirements. The yield of a given area varies with the changing patterns of precipitation, soil, cover, drainage patterns, topography, and channel density.

A method of determining sediment yield has been used for many years by the Soil Conservation Service. The estimate of sediment yield is made by use of the following equation:

$$Y = E(DR)$$

Where Y = sediment yield (tons/unit area/year)

E = gross erosion (ton/unit area/year)

DR = sediment delivery ratio (always less than 1)

Gross erosion can be estimated by use of the Universal Soil-Loss Equation. The sediment delivery ratio should be determined by a sedimentation geologist or engineer. Many interrelationships of watershed characteristics must be considered in order to determine accurate sediment delivery ratios.

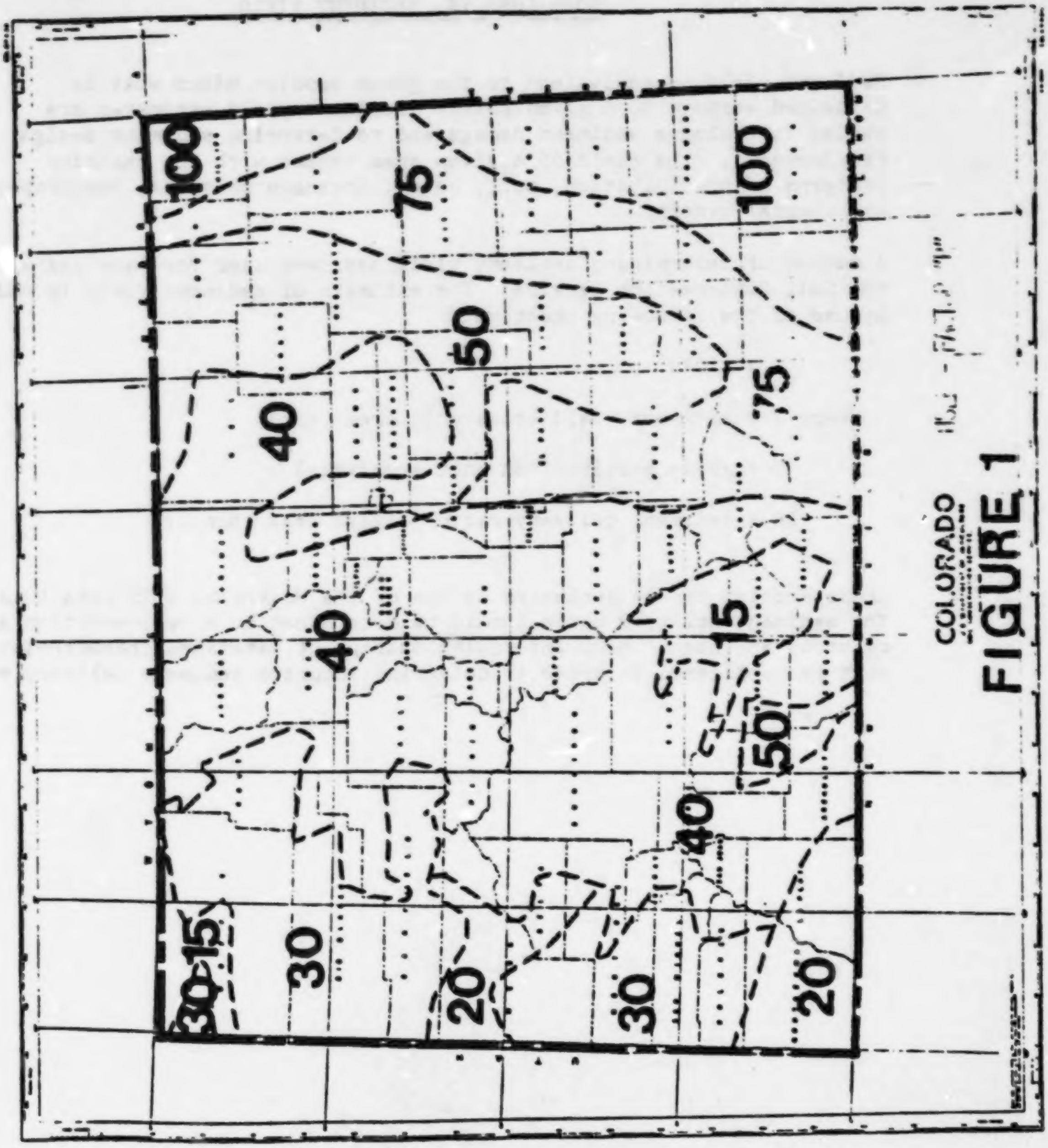
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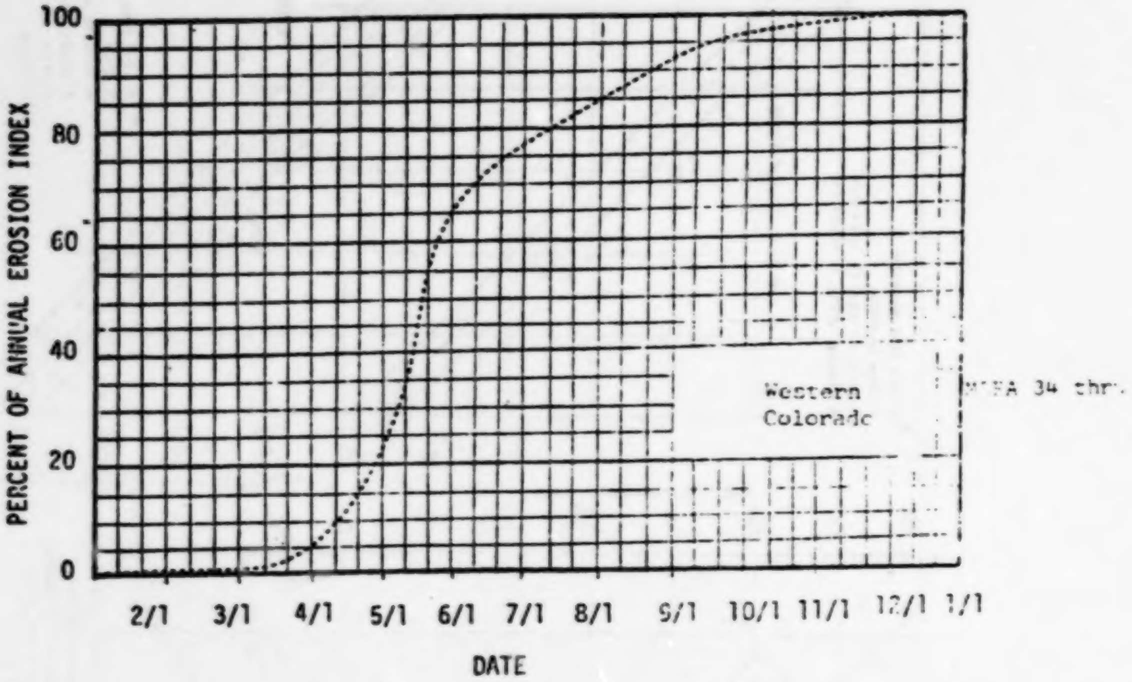
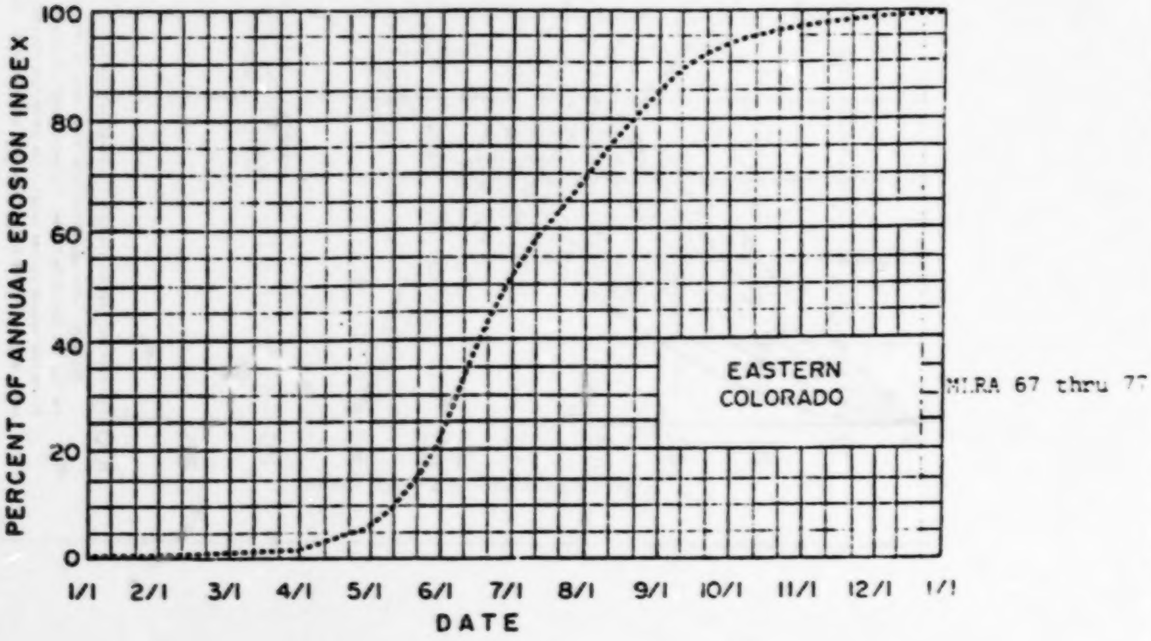
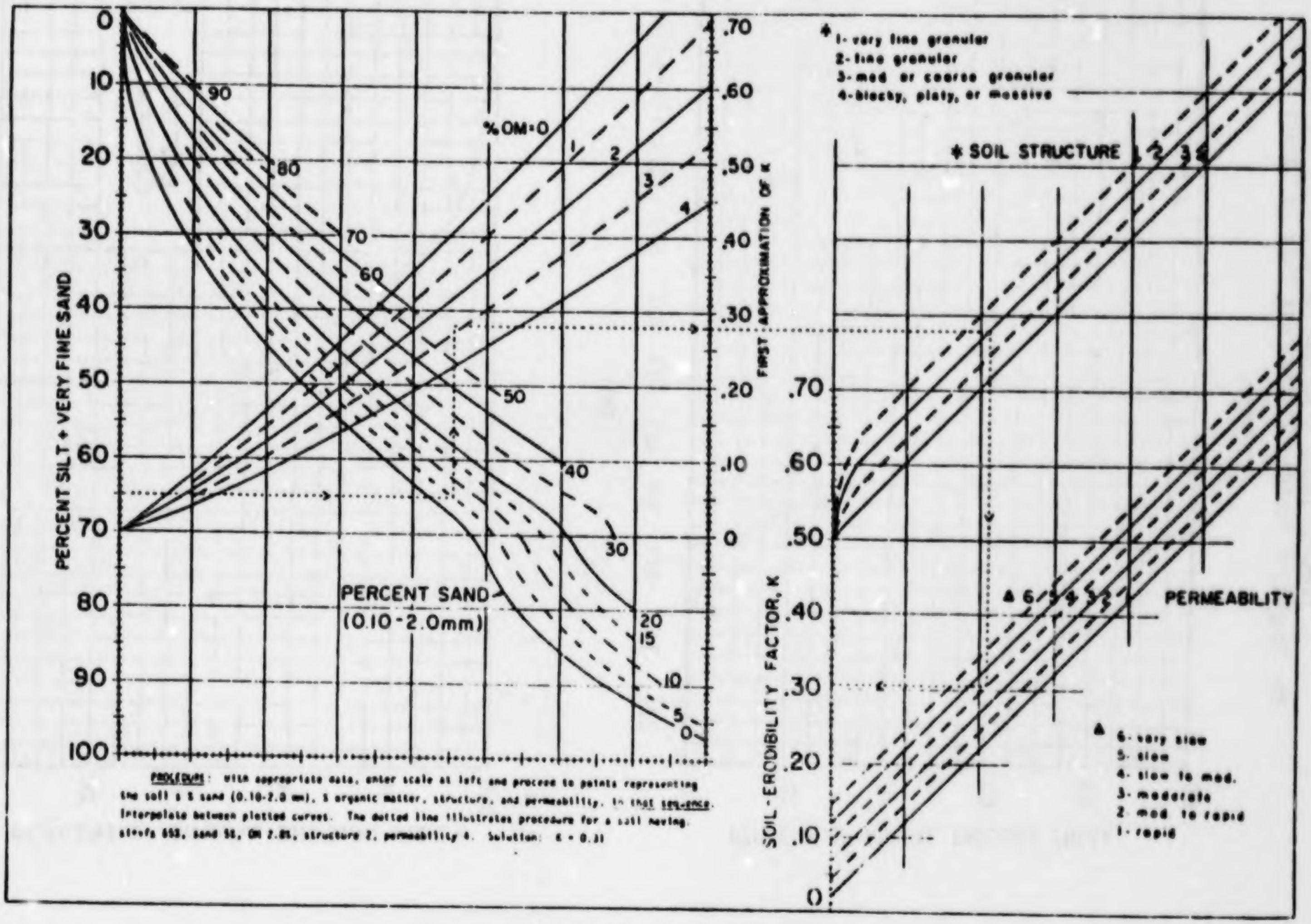
FIGURE 1

Erosion Index Distribution Curve for Computing Factor "R" for Less than 12 Months

FIGURE 2







PROCEDURE: With appropriate data, enter scale at left and proceed to points representing the soil's % sand (0.10-2.0 mm), % organic matter, structure, and permeability, in that sequence. Interpolate between plotted curves. The dotted line illustrates procedure for a soil having: si+vfs 65%, sand 5%, OM 2.8%, structure 2, permeability 4. Solution: K = 0.31

FIGURE 3 - SOIL NOMOGRAPH for DETERMINING FACTOR "K"

FIGURE 4

Values of the Topographic Factor "LS"

Length of Slope (L) Ft.	Percent Slope (S) 0.2	0.3	0.4	0.5	1.0	2.0	3.0	4.0	5.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	25.0	30.0	40.0	50.0	60.0
20	.05	.05	.06	.06	.08	.12	.18	.21	.24	.30	.44	.61	.81	1.0	1.3	1.6	1.8	2.6	3.5	5.5	8	10
40	.06	.07	.07	.08	.10	.15	.22	.28	.34	.43	.63	.87	1.2	1.4	1.8	2.2	2.6	3.5	5.0	8	11	15
60	.07	.08	.08	.08	.11	.17	.25	.33	.41	.52	.77	1.0	1.4	1.8	2.2	2.6	3.0	4.5	6.0	10	14	18
80	.08	.08	.09	.09	.12	.19	.27	.37	.48	.60	.89	1.2	1.6	2.0	2.6	3.0	3.5	5.5	7	11	16	21
100	.08	.09	.09	.10	.13	.20	.29	.40	.54	.67	.99	1.4	1.5	2.2	2.8	3.5	4.0	6.0	8	13	18	23
110	.08	.09	.10	.10	.13	.21	.30	.42	.56	.71	1.0	1.3	1.8	1.3	2.0	3.5	4.5	6.0	8	13	19	24
120	.09	.09	.10	.10	.14	.21	.30	.43	.59	.74	1.0	1.6	2.0	2.6	3.0	4.0	4.5	6.0	9	14	20	25
130	.09	.09	.10	.11	.14	.22	.31	.44	.61	.77	1.2	1.6	2.0	2.6	3.0	4.0	4.5	7	9	14	20	26
140	.09	.10	.10	.11	.14	.22	.32	.46	.63	.80	1.2	1.6	2.2	2.8	3.5	4.0	5.0	7	9	15	21	27
150	.09	.10	.11	.11	.15	.23	.32	.47	.66	.82	1.2	1.6	2.2	2.8	3.5	4.0	5.0	7	10	15	22	28
160	.09	.10	.11	.11	.15	.23	.33	.48	.68	.85	1.2	1.8	2.2	3.0	3.5	4.5	5.0	7	10	16	23	29
180	.10	.10	.11	.12	.15	.24	.34	.51	.72	.90	1.4	1.8	2.4	3.0	4.0	4.5	5.5	8	11	17	24	31
200	.10	.11	.11	.12	.16	.25	.35	.53	.76	.95	1.4	2.0	2.6	3.0	4.0	5.0	6.0	8	11	18	25	33
300	.11	.12	.13	.14	.18	.28	.40	.62	.93	1.2	1.8	.24	3.0	4.0	5.0	6.0	7	10	14	22	31	40
400	.12	.13	.14	.15	.20	.31	.44	.70	1.0	1.4	2.0	2.8	3.5	4.5	5.5	7	8	12	16	25	36	46
500	.13	.14	.15	.16	.21	.33	.47	.76	1.2	1.6	2.2	3.0	4.0	5.0	6.0	8	9	13	18	28	40	52
600	.14	.15	.16	.17	.22	.34	.49	.82	1.4	1.6	2.4	3.5	4.5	5.5	7	8	10	14	19	31	44	57
700	.15	.16	.17	.18	.23	.36	.52	.87	1.4	1.8	2.6	3.5	5.0	6.0	8	9	11	16	21	33	47	61
800	.15	.16	.17	.18	.24	.38	.54	.92	1.6	2.0	2.8	4.0	5.0	6.0	8	10	12	17	22	36	50	65
900	.16	.17	.18	.19	.25	.39	.56	.96	1.6	2.0	3.0	4.0	5.5	7	9	10	12	18	24	38	53	69
1000	.16	.18	.19	.20	.26	.40	.57	1.0	1.6	2.2	3.0	4.5	5.5	7	9	11	13	19	25	40	56	73
1100	.17	.18	.19	.20	.27	.41	.59	1.0	1.8	2.2	3.5	4.5	6.0	8	9	11	14	20	26	42	59	77
1200	.17	.18	.20	.21	.27	.42	.81	.10	.18	2.4	3.5	4.5	6.0	8	10	12	14	20	28	44	62	80
1300	.18	.19	.20	.21	.28	.43	.82	1.2	2.0	2.4	3.5	5.0	7	8	10	12	15	21	29	46	64	83
1400	.18	.19	.21	.22	.29	.44	.63	1.2	2.0	2.6	3.5	5.0	7	9	11	13	15	22	30	47	67	87
1500	.19	.20	.21	.22	.29	.45	.65	1.2	2.0	2.6	4.0	5.5	7	9	11	13	16	23	31	49	69	90
1600	.19	.20	.21	.23	.30	.46	.66	1.2	2.2	2.6	4.0	5.5	7	9	11	14	16	24	32	51	71	93
1700	.19	.21	.22	.23	.30	.47	.67	1.2	2.2	2.8	4.0	5.5	7	9	12	14	17	24	33	52	73	95
2000	.20	.22	.23	.24	.32	.49	.71	1.4	2.4	3.0	4.5	6.0	8	10	13	15	18	26	36	57	80	104

Countour limits - 2 percent 400 feet, 8 percent 200 feet, 10 percent 100 feet, 14 - 24 percent 60 feet. The effectiveness of contouring beyond these limits is speculative.

When the length of slope exceeds 400 feet and (or) percent of slope exceeds 24 percent, soil loss estimates are speculative as these values are beyond the range of research data.

FIGURE 5
CROP MANAGEMENT FACTOR "C" EASTERN COLORADO

Cropping Sequence	Management Practice	"C" Factor
Wheat, grain sorghum & fallow	Minimum tillage	
	Fallow operations (wheat)	
	None - summer & fall	
	3 or 4 - spring & summer	
	500-1,000 lbs wheat residue	
	0-200 lbs sorghum residue	0.39
	200-500 lbs sorghum residue	0.38
	500-1,000 lbs sorghum residue	0.33
	1,000-1,500 lbs sorghum residue	0.27
	1,500-2,000 lbs sorghum residue	0.24
	2,000-2,500 lbs sorghum residue	0.22
Wheat, fallow corn (grain), fallow	Minimum tillage	
	Fallow operations	
	None - summer & fall	
	3 or 4 - spring & summer	
	500-1,000 lbs wheat residue	
	500-1,000 lbs corn residue	0.32
Wheat, corn (grain), fallow	Minimum tillage	
	Fallow operations (wheat)	
	None - summer & fall	
	3 or 4 - spring & summer	
	500-1,000 lbs wheat residue	
	500-1,000 lbs corn residue	0.34
	1,000-1,500 lbs corn residue	0.28
	1,500-2,000 lbs corn residue	0.25
	2,000-2,500 lbs corn residue	0.23
Corn (grain) & fallow	Minimum tillage	
	Fallow operations	
	None - summer & fall	
	3 or 4 - spring & summer	
	500-1,000 lbs residue	0.50
	1,000-1,500 lbs residue	0.40
	1,500-2,000 lbs residue	0.34
	2,000-2,500 lbs residue	0.31
Grain sorghum & fallow	Minimum tillage	
	Fallow operations	
	None - summer & fall	
	3 or 4 - spring & summer	
	0-200 lbs residue	0.61
	200-500 lbs residue	0.51
	500-1,000 lbs residue	0.50
	1,000-1,500 lbs residue	0.39
	1,500-2,000 lbs residue	0.33
	2,000-2,500 lbs residue	0.30
Continuous grain sorghum	Minimum tillage	0.44
	Conventional tillage	0.52
	Till planting *	
	500-750 lbs sorghum residue	0.56
	750-1,000 lbs sorghum residue	0.45
	1,000-1,500 lbs sorghum residue	0.36
	1,500-2,000 lbs sorghum residue	0.28
	2,000-3,000 lbs sorghum residue	0.22
	3,000-4,000 lbs sorghum residue	0.15
	4,000-6,000 lbs sorghum residue	0.07

Till planting * Seedbed preparation consists of stalk cutting and light disking. Seedrow zones only 8 to 17 inches wide.

FIGURE 5 Cont'd

CROP MANAGEMENT FACTOR "C" EASTERN COLORADO

Cropping Sequence	Management Practice	"C" Factor
Wheat & fallow	Minimum tillage	
	Fallow operations	
	1-summer & fall	
	3-spring & summer	
	500-1,000 lbs residue	0.21
	1,000-1,500 lbs residue	0.13
	1,500-2,000 lbs residue	0.07
Wheat & fallow	Minimum tillage	
	Fallow operations	
	None - summer & fall	
	4-spring & summer	
	0-200 lbs residue	0.39
	200-500 lbs residue	0.31
	500-1,000 lbs residue	0.21
	1,000-1,500 lbs residue	0.14
	1,500-2,000 lbs residue	0.09
Wheat & fallow	Minimum tillage	
	Fallow operations	
	1-summer & fall	
	4-spring & summer	
	0-200 lbs residue	0.40
	200-500 lbs residue	0.37
	500-1,000 lbs residue	0.25
	1,000-1,500 lbs residue	0.15
	1,500-2,000 lbs residue	0.05
Wheat & fallow	Conventional tillage	
	Fallow operations	
	2-summer & fall	
	6-spring & summer	
	0-200 lbs residue	0.57
	200-500 lbs residue	0.46
Wheat & fallow	Conventional tillage	
	Fallow operations	
	1-summer & fall	
	7-spring & summer	
	0-200 lbs residue	0.55
	200-500 lbs residue	0.45
Wheat & fallow	Conventional tillage (Moldboard plowing)	
	Fall plowing	0.55
Wheat & fallow	Conventional tillage (Moldboard plowing)	
	Spring plowing	0.37

FIGURE 6
CROP MANAGEMENT FACTOR "C" WESTERN COLORADO

Cropping Sequence	Management Practice	"C" Factor
Winter wheat & fallow	First fallow operation in fall of year	
	Moldboard plow	
	No residue	0.46
	Minimum tillage	
	0-200 lbs residue	0.42
	200-500 lbs residue	0.31
	500-1,000 lbs residue	0.23
	1,000-1,500 lbs residue	0.13
	1,500-2,000 lbs residue	0.07
Winter wheat Fallow Winter wheat (frozen out) Spring wheat	First fallow operation in spring of year	
	Moldboard plow	
	No residue	0.47
	Minimum tillage	
	0-200 lbs residue	0.44
	200-500 lbs residue	0.35
	500-1,000 lbs residue	0.22
	1,000-1,500 lbs residue	0.15
	1,500-2,000 lbs residue	0.10
Continuous Winter wheat	Moldboard plow	
	No residue	0.34
	Minimum tillage	
	0-200 lbs residue	0.34
	200-500 lbs residue	0.31
	500-1,000 lbs residue	0.18
	1,000-1,500 lbs residue	0.13
	1,500-2,000 lbs residue	0.09
Continuous wheat -Winter wheat (frozen out) -Spring wheat	Moldboard plow	
	No residue	0.58
	Minimum tillage	
	0-200 lbs residue	0.58
	200-500 lbs residue	0.56
	500-1,000 lbs residue	0.34
	1,000-1,500 lbs residue	0.21
	1,500-2,000 lbs residue	0.13
Winter wheat & fallow	First fallow operation in spring of year	
	Moldboard plow	
	No residue	0.33
	Minimum tillage	
	0-200 lbs residue	0.29
	200-500 lbs residue	0.24
	500-1,000 lbs residue	0.16
	1,000-1,500 lbs residue	0.12
	1,500-2,000 lbs residue	0.09
Continuous beans		0.59
1 yr beans & 1 yr wheat		0.27
2 yrs beans & 1 yr wheat		0.38
3 yrs beans & 1 yr wheat		0.43
4 yrs beans & 1 yr wheat		0.47
5 yrs beans & 1 yr wheat		0.49
Alfalfa seed production (Rows) - includes year of establishment		0.21
5 yrs alfalfa & grass - includes year of establishment (Pasture & Hayland) 1 yr fallow 2 yrs beans		0.23
Grass seed production (Rows) - includes year of establishment		0.21

FIGURE 7

"C" Factors for Permanent Pasture and Rangeland 1/

Vegetative Canopy			Cover That Contacts the Surface					
Type and Height of Raised Canopy 2/	Canopy Cover 3/ %	Type 4/	Percent Ground Cover					
			0	20	40	60	80	95-100
Column No.:	2	3	4	5	6	7	8	9
No appreciable canopy		G	.45	.20	.10	.042	.013	.003
		W	.45	.24	.15	.090	.043	.011
Canopy of tall forbs or short brush (0.5 m fall ht.)	25	G	.36	.17	.09	.038	.012	.003
		W	.36	.20	.13	.082	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.075	.039	.011
	75	G	.17	.10	.06	.031	.011	.003
		W	.17	.12	.07	.067	.038	.011
Appreciable brush or brushes (2 m fall ht.)	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.085	.042	.011
	50	G	.34	.16	.085	.038	.012	.003
		W	.34	.19	.13	.081	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.077	.040	.011
Trees but no appreciable low brush (4 m fall ht.)	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.087	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.085	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.083	.041	.011

1/ All values shown assume: (1) random distribution of mulch or vegetation, and (2) mulch of appreciable depth where it exists.

2/ Average fall height of waterdrops from canopy to soil surface: m = meters.

3/ Portion of total-area surface that would be hidden from view by canopy in a vertical projection, (a bird's-eye view).

4/ G: Cover at surface is grass, grasslike plants, decaying compacted duff, or litter.

W. Cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface, and/or undecayed residue.)

FIGURE 8

Factor "C" for Various Quantities of Mulch

Mulch - adequately crimped into soil	"C" Factor
bare areas	1.0
1/4 ton straw mulch per acre	.52
1/2 " " " " "	.35
3/4 " " " " "	.24
1 " " " " "	.18
1-1/2 " " " " "	.10
2 " " " " "	.06
3 " " " " "	.03
4 " " " " "	.02

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FIGURE 9
"C" Factors for Woodland

1/ Tree Canopy % of Area	2/ Forest Litter % of Area	3/ Undergrowth	"C" Factor
100-75	100-90	Managed 4/ Unmanaged 4/	.001 .003-.011
70-40	85-75	Managed Unmanaged	.022-.004 .01-.04
35-20	70-40	Managed Unmanaged	.003-.009 5/

1/ When tree canopy is less than 20%, the area will be considered as grassland, or cropland for estimating soil loss. See Table 1.

2/ Forest litter is assumed to be at least two inches deep over the percent ground surface area covered.

3/ Undergrowth is defined as shrubs, weeds, grasses, vines, etc., on the surface area not protected by forest litter. Usually found under canopy openings.

4/ Managed - grazing and fires are controlled.
Unmanaged - stands that are overgrazed or subjected to repeated burning.

5/ For unmanaged woodland with litter cover of less than 75%, C values should be derived by taking 0.7 of the appropriate values in Table 5. The factor of 0.7 adjusts for the much higher soil organic matter on permanent woodland.

FIGURE 10

"P" FACTORS FOR CONSERVATION PRACTICES

Slope (Percent)	Up & Down Hill	Cross Slope Farming Without Strips	Contour Farming	Cross Slope Farming With Strips	Contour Strip Cropping
2.0- 7.0	1.0	0.75	0.50	0.37	0.25
7.1-12.0	1.0	0.80	0.60	0.45	0.30
12.1-18.0	1.0	0.90	0.80	0.60	0.40
18.1-24.0	1.0	0.95	0.90	0.67	0.45

1/ Contour limits - 2 percent 400 ft, 8 percent 200 ft, 10 percent 100 ft, 14-24 percent 60 ft. [redacted]

This appendix contains selected copies of relevant correspondence pertaining to Metro's attempts to obtain land in the Rocky Mountain arsenal for the Drying and Distribution Center.

March 22, 1971

Lt. Colonel Harold W. Shear
Commanding Officer
Rocky Mountain Arsenal
Denver, Colorado 80240

Dear Colonel Shear:

Approval is requested for the Metropolitan Denver Sewage Disposal District No. 1 to utilize a portion of Rocky Mountain Arsenal property for the application of dewatered sewage sludge to the soil. The proposed project can provide multiple benefits. These benefits include improvement of specific soils for vegetation, providing of a better location for periodic disposal of sewage sludge from the Metropolitan Denver Sewage Disposal District No. 1 treatment facilities, and research information which hopefully can encourage beneficial application of sewage sludge to the soil throughout the United States.

Enclosed are letters from the Colorado Water Pollution Control Division and the Air Pollution Control Division of the Colorado Department of Public Health and the Tri-County District Health Department indicating support of the proposed project on a trial basis for a period of approximately eight weeks. Other letters from the Adams County Commissioners and other governmental agencies supporting this proposed use of Rocky Mountain Arsenal property will be submitted when they are received. Verbal approval to this trial basis project has been given by the Adams County Commissioners. If the sludge application project proves satisfactory to all concerned parties, the Metropolitan Denver Sewage Disposal District No. 1 would wish to continue the project until some other method of recycling sludge to the soil would be developed and adopted. Other such methods are now under study by the Metro District staff.

Also enclosed are small maps which indicate the area in the southwest corner of Section 20 within the Rocky Mountain Arsenal property on which the District would propose to perform this sludge

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application to the soil.

Use by the Metropolitan Denver Sewage Disposal District No. 1 of the proposed Rocky Mountain Arsenal site for the application of dewatered sludge to the soil would provide significant financial savings to the District. It is proposed that the trial demonstration project be performed on the basis of applying sludge 24 hours per day for a period of approximately two weeks, followed by a four week period of no sludge application, then followed by another two week period of sludge application at the Arsenal site. After the second period of sludge application it would be appropriate for all concerned parties to decide whether they would favor continuation of the established procedure of application or would favor a revised procedure throughout the future. I should mention that Mr. Donnelly, Director of Facilities at the Rocky Mountain Arsenal, is familiar with the proposed methods to be employed.

It is presently the intention of the Board of Directors of the Metropolitan Denver Sewage Disposal District No. 1 to eliminate incineration of sewage sludge and to contract for application of liquid sludge to the soil at one or more sites throughout eastern Colorado. This new system of liquid sludge application would hopefully commence by March or April of 1972.

The sludge application project at the Rocky Mountain Arsenal would be comparable to that which has been in process at the Lowry Bombing Range for the past year. Trucks with sealed boxes would haul dewatered sludge (approximately 16% solids content) to the Rocky Mountain Arsenal site and unload the sludge into agricultural manure spreaders. The manure spreaders pulled by a 70 H.P. agricultural tractor would distribute the sludge over a 10 to 12 feet wide path at a rate of application of approximately 10 dry tons per acre. It is anticipated that three applications would be attempted totalling 30 dry tons per acre. This is a relatively low application rate for sewage sludge. Following each application a rotary hoe will be used to pulverize a thin layer of soil and mix it with the sludge. This operation will not harm the existing vegetive cover, but will provide soil conditioning and fertilizer benefits to the soil.

Experience with the Lowry operation has indicated no problems with the transportation of the sludge or with any odor, water pollution or air pollution problems at the sludge application site.

Inasmuch as the need for financial savings to the District is immediate and the time during which dewatered sludge will be available is limited, it is requested that a decision on this request be provided at an early date. Your favorable consideration of this request will be most helpful to the people of the metropolitan Denver area and will be most sincerely appreciated by the Board of Directors of the Metropolitan Denver Sewage Disposal District No. 1.

Yours very truly,

William E. Korbitz, P.E.
Manager

WEK/d
CC - Ed C. Hoskinson

Enclosures

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY MATERIEL COMMAND
WASHINGTON, D.C. 20315

1 JUN 1971

Honorable James D. Mc Kevitt

House of Representatives

Dear Mr. Mc Kevitt:

This is in reply to your inquiry in behalf of the Metropolitan Denver Sewage Disposal District in connection with its desire to dispose of dewatered sewage sludge at Rocky Mountain Arsenal, Denver, Colorado.

The proposal, although it may result in benefit to the soil, cannot be approved at this time because of sensitive demilitarization (DEMIL) of toxic chemical munitions conducted at that installation. The safety and security restrictions imposed for DEMIL operations prohibit favorable consideration of the request until the operations are completed, estimated to be in fiscal year 1975.

Sincerely,

Paul Cyr
PAUL CYR
Special Assistant for
Congressional Affairs

RECEIVED
JUN 3 1971
J. D. "MIKE" McKEVITT, M.C.

September 11, 1974

The Honorable Howard Callaway
Secretary of the Army
The Pentagon
Washington, D. C. 20025

Dear Mr. Secretary:

It is respectfully requested that approximately 2,000 acres of land in the northeast corner of the Rocky Mountain Arsenal be furnished to the Metropolitan Denver Sewage Disposal District No. 1 for an organic solids processing facility for the metropolitan Denver area. The subject land includes parts of Sections 19, 20, 29, 30 and 32 in Range 66 West, Township 2 South.

The activity intended by the District, to commence in mid 1976 to late 1976, includes air drying of sludge in large drying basins totalling about 300 acres, the subsurface injection of sludge on several hundred acres, and extensive research plots as well as a landscaped buffer zone around the periphery of the property. The sludge will be biologically stabilized so there would be no obnoxious odors, fly or rodent problems. Many decades of experience with this type of sludge has indicated that there is no need to fear problems from heavy metals, bacteria, viruses or other health or environmental hazards. The plan of the District for beneficial reuse of organic solids (sewage sludge) includes anaerobic digestion of the sludge at a central treatment plant located in Commerce City, the piping of the sludge of approximately 4% solids content to the processing site, and at the processing site providing air drying of some of the sludge, subsurface injecting of some of the sludge, and using the balance of the sludge in continuing research efforts of the District. At some later date, some of the sludge may be pulverized, pelletized, stockpiled, sacked and sold.

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This is an excellent opportunity for the Department of the Army to participate in a significant environmental and energy conservation activity which could provide significant national as well as regional benefits. I sincerely hope that this request will receive your most serious consideration.

Additional information including maps will be provided to the appropriate personnel of the Department of the Army at such time as such personnel find need for such additional information.

Respectfully,

William E. Korbitz, P.E.
Manager

cc: Mary B O'Dell
WEK/j

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY MATERIEL COMMAND
5001 EISENHOWER AVE., ALEXANDRIA, VA. 22304 33

26 September 1974

Mr. William E. Korbitz, Manager
Metropolitan Denver Sewage Disposal
District No. 1
3100 East 60th Avenue
Commerce City, Colorado 80022

Dear Mr. Korbitz:

The Secretary of the Army has asked me to reply to your inquiry in which you requested that the Army furnish approximately 2000 acres of Rocky Mountain Arsenal land, to the Metropolitan Denver Sewage Disposal District No. 1, for use in your proposed sludge disposal project.

The Department of Defense Explosive Safety Board has consistently disapproved the release of any land at Rocky Mountain Arsenal until the current demilitarization program is completed. This is now scheduled for late in 1976.

In view of the current situation surrounding Rocky Mountain Arsenal, it is suggested that the Denver Sewage Disposal District explore alternate solutions and not plan on using Arsenal land. However, if no other solution can be found, your request will be reexamined a year from now.

I regret that the circumstances in this instance preclude a more favorable reply.

Sincerely,

NEIL S. GODWIN
Acting Special Assistant
for Congressional Affairs

September 11, 1974

The Honorable Howard Callaway
Secretary of the Army
The Pentagon
Washington, D. C. 20025

Dear Mr. Secretary:

It is respectfully requested that approximately 2,000 acres of land in the northeast corner of the Rocky Mountain Arsenal be furnished to the Metropolitan Denver Sewage Disposal District No. 1 for an organic solids processing facility for the metropolitan Denver area. The subject land includes parts of Sections 19, 20, 29, 30 and 32 in Range 66 West, Township 2 South.

The activity intended by the District, to commence in mid 1976 to late 1976, includes air drying of sludge in large drying basins totalling about 300 acres, the subsurface injection of sludge on several hundred acres, and extensive research plots as well as a landscaped buffer zone around the periphery of the property. The sludge will be biologically stabilized so there would be no obnoxious odors, fly or rodent problems. Many decades of experience with this type of sludge has indicated that there is no need to fear problems from heavy metals, bacteria, viruses or other health or environmental hazards. The plan of the District for beneficial reuse of organic solids (sewage sludge) includes anaerobic digestion of the sludge at a central treatment plant located in Commerce City, the piping of the sludge of approximately 4% solids content to the processing site, and at the processing site providing air drying of some of the sludge, subsurface injecting of some of the sludge, and using the balance of the sludge in continuing research efforts of the District. At some later date, some of the sludge may be pulverized, pelletized, stockpiled, sacked and sold.

The Metro Denver Sewage Disposal District is dedicated to the beneficial use of sewage sludge with savings in commercial fertilizer and energy. The continued use of the Lowry Bombing Range where the Metro District presently recycles its sludge will probably result in retardation of growth and also limits the beneficial use of the sludge to some 1,500 acres of land and only one cattleman rather than to many thousands of acres of land and scores of farmers and other users.

At your earliest opportunity I would appreciate learning of any plans for disposal of portions of the Rocky Mountain Arsenal land, also information concerning what is needed by you for a decision on this Metro Denver District request as well as other pertinent information. I sincerely hope that the Department of the Army will be able to participate in this valuable program of providing increased food production, alleviating the present critical fertilizer shortage in the United States, relieving the critical energy shortage problem, and providing general improvement to the environment.

Respectfully,

William E. Korbitz, P.E.
Manager

cc: Senator Floyd Haskell
Senator Gary Hart
Congressman William Armstrong
Congresswoman Patricia Schroeder
Congressman Timothy Wirth
Mary B. O'Dell
Robert C. McWhinnie

WEK/j

January 23, 1976

The Honorable Richard D. Lamm
Governor of Colorado
State Capitol Building
Denver, Colorado 80203

Dear Governor Lamm:

Enclosed is a copy of a letter addressed to the Secretary of the Army concerning the use of Rocky Mountain Arsenal land by the Metropolitan Denver Sewage Disposal District No. 1. Subsequent to sending the letter to Secretary Hoffman, I learned that you had established a committee concerning arsenal land use, and I would like to have the request of the Metro Denver Sewage District considered in connection with future Rocky Mountain Arsenal land use.

In the event that the Metro Denver Sewage Disposal District officials and personnel can be of help in connection with Rocky Mountain Arsenal land use planning, please so advise me.

Respectfully,

William E. Korbitz, P.E.
Manager

Enc.

WEK/blm

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
WASHINGTON, D.C. 20310

REPLY TO ATTENTION OF: DAMO-ODC

29 JAN 1976

City Council
Municipal Building
Aurora, Colorado 80010

Gentlemen:

I have been asked to respond to your January 6th correspondence regarding retention of Rocky Mountain Arsenal.

As you are aware, we have an active program of demilitarization of chemical warfare agents on-going at Rocky Mountain Arsenal. Rocky Mountain Arsenal is also the site of our GB agent/munitions production facilities which will continue as a mobilization stand-by after completion of current demilitarization.

The Army operates a hydrazine blending facility on the Arsenal for the Air Force and another portion is leased to the Shell Chemical Company. There are no Departmental plans to alter these arrangements.

We recognize the outstanding contributions to our national chemical posture made by Aurora citizens, and will continue to rely on their dedication in any future Rocky Mountain Arsenal programs. We will continue to inform state and local officials regarding the status of the Arsenal.

Sincerely,

Charles E. Canedy
CHARLES E. CANEDY
Brigadier General, GS
Deputy Director of Operations

FEB 3 '76
CITY MANAGER

DEPARTMENT OF THE ARMY Development & Readiness Cmd
HEADQUARTERS UNITED STATES ARMY MATERIEL ~~COMMAND~~
5001 EISENHOWER AVE., ALEXANDRIA, VA. ~~22304~~ 22333

DRCIS-MR

11 FEB 1976

Mr. William E. Korbitz, Manager
Metropolitan Denver Sewage Disposal
District No. 1
3100 East 60th Avenue
Commerce City, Colorado 80022

Dear Mr. Korbitz:

The Secretary of the Army has asked me to reply to your inquiry wherein you requested the Army to provide 2000 acres of the Rocky Mountain Arsenal to the Metropolitan Denver Sewage Disposal District No. 1 for sludge disposal.

In our letter to you on 26 September 1974 we explained that the Department of Defense Explosive Safety Board has consistently opposed the release of any land at the arsenal until the demilitarization program is completed. This program has now been rescheduled for completion during fiscal year 1977.

As long as this demilitarization program continues, all the land comprising the arsenal must remain under the control of the Department of the Army and none can be made available at this time.

I regret that a more favorable response could not be made to your request; however, I trust you will understand our position.

Sincerely,

Charles R Smith
CHARLES R. SMITH
Special Assistant for
Congressional Affairs

This appendix contains the proposal by the U.S.G.S. to install and maintain monitoring wells and lysimeters at Site B-2 to detect possible groundwater contamination beneath the site.

PROJECT PROPOSAL

WATER RESOURCES INVESTIGATION

SLUDGE DRYING SITE
ADAMS COUNTY
COLORADO

by

S. G. ROBSON

MARCH 1977

INTRODUCTION

The Metropolitan Denver Sewage Disposal District No. 1 (MDSDD) plans to replace the current sewage sludge land disposal area east of Denver, Colorado, with sludge drying basins to facilitate sludge disposal and allow use of dried sludge as fertilizer. It is planned that about 600 acres of drying basins will be contained in the 2,000-acre site which is located about 25 miles northeast of Denver. About 100 dry tons of sludge per day will be pumped through slurry pipelines to the drying basins. The MDSDD, the Environmental Protection Agency, and local residents are concerned over the effects the estimated 22 acre-feet per year of drying basin leachate could have on local ground-water quality.

PROBLEM

Although about 20 unused or domestic wells are thought to be located within a 3-mile radius of the drying basin site, no well data are available to determine the lateral extent or depth of alluvial and bedrock aquifers in the area. The native ground-water chemical quality and direction of movement are also ill defined. In addition, no on-site data are available to determine the volume or chemical quality of sludge leachate that will percolate from the basins. As a result, the effects of the drying basins on local ground-water quality cannot be accurately determined from existing data. The distribution of existing wells is such that it will not be possible to monitor the ground-water quality near the site without additional wells.

PROPOSAL

It is proposed that a ground-water quality monitoring program be established within a 28-square-mile area around the drying site.

Objective: The purpose of the water-quality monitoring program would be to gather data describing the location, depth, and extent of permeable and impermeable materials beneath the drying site, depth to ground water, chemical quality of ground water and leachate, and the rate of leachate movement into the unsaturated zone. These data would allow a determination of the depth and lateral extent of alluvial and bedrock aquifers at the drying site. The direction of movement and chemical quality of the native ground water would also be defined, as will the volume of leachate movement into the unsaturated zone and the chemical quality of the leachate. This information would allow an assessment of the probable long-term effects of the drying basins on the local ground-water quality and should have transfer value to similar installations in other areas. Continued monitoring of ground-water quality in the study area will provide information about the current effects of leachate movement on local ground-water quality.

Approach: The 28 square-mile study area, centered around the drying basin site, is located in an area of rolling hills and shallow valleys.

Bedrock consisting of mudstone and sandstone of the Denver Formation occurs beneath a shallow veneer of alluvium on the hills, and is overlain by as much as 40 feet of alluvium in the valleys. Ground water is thought to occur at depths of about 200 feet in the bedrock and at shallow depths in the larger alluvial valleys. No natural ground water is thought to occur in the alluvium under the drying basin site although leachate may ultimately form a saturated zone in this area. Stream channels are normally dry and only carry flow following heavy precipitation.

It is proposed that about 40 wells be drilled and cased for ground-water quality monitoring near the site. Twenty-nine on-site wells and 5 off-site wells will be drilled and cased to enable sampling of any water in saturated permeable zones in the alluvial materials. Six sites will be drilled for installation of multiple piezometers in any permeable zones found in the upper 100-200 feet of the bedrock formation. In addition, it is planned that six pan-type lysimeters will be installed under selected drying basins in order to determine the rate of leachate movement and obtain leachate samples for chemical analysis. Eight domestic wells and 12 unused wells are thought to be located within a 3-mile radius of the drying basins. It is planned that as many as possible of these wells will be sampled for water-quality analysis. It will be necessary to get the property owners permission to renovate the existing unused wells before they can be sampled.

If the ground-water quality is degraded by basin leachate, the zone of degraded water will originate near the basins and slowly spread to more distant locations. As a result, water-quality samples from locations near the drying basins will be gathered at more frequent intervals than will samples from more distant locations. The lysimeters under the drying basins will probably be sampled on a monthly basis with wells near the drying basins sampled on a quarterly basis. The off-site wells to be drilled and the existing domestic and unused wells will be sampled on an annual basis. This sampling schedule will be intensified if changes in ground-water quality are thought to warrant either more frequent sampling or the installation of additional observation wells. If insufficient water for chemical analysis accumulates in the lysimeters during the one-month sampling interval, the sampling frequency may be reduced in order to obtain an adequate volume of sample.

The samples obtained during the first 1 to 2 years of monitoring will be analyzed for all major anions and cations, selected inorganic nutrients, heavy metals, dissolved solids, and dissolved organic carbon. Once baseline concentrations have been established for native ground water and leachate, the list of determined constituents will be reduced to eliminate repeated analysis of constituents not found to be useful indicators of water-quality degradation.

The majority of the water-quality analyses will be performed in the MDSDD Laboratory, with supplemental and check analyses on split samples analyzed in the USGS Laboratory. The analytical techniques used by the USGS Laboratory have produced analytical results which in the past have been comparable to the results obtained from the MDSDD laboratory.

Cost and Timing: It is proposed that the initial phase of the ground-water monitoring near the drying site be undertaken over a 3-year period.

First Year (1977 FY)

Canvas, measure, and sample, if possible, all existing wells in the study area. Construct potentiometric contour maps for the bedrock and alluvial aquifers to aid in selection of site and depth of subsequent observation wells. The 1977 fiscal year funding required is $13,060, of which the USGS and MDSDD will contribute equal shares of $6,530. The MDSDD funding will include $3,000 worth of laboratory services for which they will receive direct credit.

Second Year (1978 FY)

The primary expense during the second year of the study results from the installation of new wells and lysimeters, renovation of existing unused wells and the analysis of water-quality samples. It is estimated that the 1978 FY funding required will be $75,750. MDSDD and USGS shares would be $37,875 with MDSDD receiving direct credit for $15,000 worth of laboratory services.

Third Year (1979 FY)

Work undertaken in the third year of the study involves water-quality sampling and analysis and preparation of a report documenting the findings of the first three years' work. Funding for the third and subsequent years of water-quality monitoring is difficult to estimate at this time for the number of dry wells in the monitoring network cannot be readily estimated. Current estimates indicate that $42,330 of funding will be required with MDSDD and USGS contributions of $21,165. MDSDD will receive direct credit for $15,000 worth of laboratory services.

Report Format:

It is anticipated that the final report will be published as part of the USGS Water-Resources Investigation series. The report should contain about 10 illustrations and 100 pages including an appendix of data collected during the study. The content and format of the report should be very similar to the report "Ground-water quality near a sewage-sludge recycling site and a landfill near Denver, Colo." prepared in cooperation with the MDSDD in 1976.